

CONFIDENTIAL

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DETAILED TEST OBJECTIVES
FOR
NASA MISSION MA-6

Prepared by
Mercury/Atlas Launch Vehicle Program Office

AEROSPACE CORPORATION
El Segundo, California

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AFMTC film courier _____

NASA escort _____

MERCURY CONTROL

T - 120 min. The nerve center of Mercury, this position outside of building where you view and possibly interview NASA officials coming in and out of the center.

TV Unit #3 - S pad and abort pool could cover this position.

Commentator _____

Newsreels

1. _____
2. _____

Still Photographers

1. Black-and-white _____
2. Color _____
3. Stereo _____

Writers

Wire Service

1. _____
2. _____

Periodicals

1. _____

Newspapers

1. _____

AFMTC escort _____

AFMTC film courier _____

DOWN RANGE

Third orbit recovery area.

Prime recovery ship (Carrier)

NASA PIO _____

NASA Photographer _____

TV video tape truck and technicians.

Commentator _____

Newsreels

1. Cameraman _____
2. Soundman _____

Still Photographers

1. Black-and-White _____
2. Color _____
3. Stereo _____

Writers

Wire Service

1. _____
2. _____

Periodicals

1. _____

FOREWORD

This document was prepared in accordance with the specifications presented in Reference (a) as part of the National Aeronautics and Space Administration (NASA) Project Mercury.

The NASA Mission Mercury/Atlas-6 (MA-6) is the seventh* of a series developed to provide the ability to place a manned satellite into orbit around the earth and then return it and its pilot safely to the surface.

* Previous Mercury/Atlas missions were: "Big Joe" (Vehicle 10-D) - 9/9/59; MA-1 (Vehicle 50-D) 7/29/60; MA-2 (Vehicle 67-D) - 2/21/61; MA-3 (Vehicle 100-D) - 4/25/61; and MA-4 (Vehicle 88-D) - 9/13/61, and MA-5(93-D)-scheduled for 11/61.

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1. INTRODUCTION**1.1 Scope**

This Detailed Test Objectives (DTO) Report designates the plan for the launch and powered flight phase of the Mercury/Atlas Vehicle, assigned to support the NASA MA-6 mission at the Atlantic Missile Range (AMR). The report specifies the test objectives, data requirements, vehicle general configuration, recommended ground equipment and AMR support, systems operation specifications, test procedures, and trajectory necessary to conduct the flight in the prescribed manner, except for the following exclusions:

- 1.1.1 The DTO does not include detailed descriptions or detailed operating specifications for the Mercury capsule systems. These elements will be contained in References (b), (c), (d), and (g).
- 1.1.2 The DTO does not specify the facilities, procedures, or other support elements required for the free-flight and recovery of the Mercury capsule. These elements will be specified in Reference (b). The NASA mission rules will be presented in the Flight Test Directive (FTD).
- 1.1.3 The DTO does not specify the detailed test procedures required to perform Atlas systems checkouts during pre-launch and countdown. These elements will be specified in the FTD.

1.2 Purpose

The DTO was established by Reference (c) and modified to fit the Project Mercury operations to fulfill the following purposes:

- 1.2.1 To serve as the primary document for the coordination of the test plan between the NASA and SSD/AEROSPACE.

- 1.2.2 To furnish the flight planning details that are necessary for the establishment of the detailed test procedures within the FTD and the detailed support requirements within the Operations Requirements (OR).

1.3 Precedence of Reports

In case of conflict between the DTO and the test plans prepared by the Atlas Associate Contractors, the DTO will take precedence. In case of conflict between the DTO and the detailed test procedures within the FTD, the FTD will take precedence. In cases of conflict between the DTO and the operational procedures and support requirements for the Mercury capsule within the OR, the OR will take precedence.

1.4 Amendments

This DTO will be amended as required to reflect approved changes in the over-all plan for the flight. Last minute changes will be transmitted by TWX to NASA, 6555th Test Wing AMR, Atlas Associate Contractors, and/or agencies affected. Published copies of the changes will be mailed to all agencies and personnel on the original DTO distribution list.

2. GENERAL TEST PLAN

- 2.1 The Mercury/Atlas vehicle will propel the capsule containing an astronaut on a launch trajectory satisfying Mercury Program orbital insertion conditions. The vehicle will be guided to provide capsule insertion into an elliptical orbit with a perigee of approximately 87 nautical miles and an apogee of approximately 137 nautical miles. The capsule will orbit the earth three times with flight terminating during the third pass when re-entry will be initiated by firing the capsule retrorockets upon command signal from either the airborne capsule clock, the astronaut, or the Mercury tracking network station No.13 located near Pt. Arguello, California. The trajectory terminates at about 22°00' N and 70°00' W, Northeast of the Dominican Republic, where the capsule is to be recovered.
- 2.2 The primary purpose of the mission is to evaluate the performance of a man-spacecraft system in a three orbit mission, to evaluate the effects of space flight on the astronaut, and to obtain the astronaut's opinions on the operational suitability of the capsule and supporting systems for manned space flight.
- 2.3 Three-seconds of holddown time delay will be used in conjunction with suitably instrumented active dual rough combustion cutoff (RCC) accelerometers and ground circuitry on each booster thrust chamber and one RCC system on the sustainer thrust chamber.

3. TEST OBJECTIVES**Order of
Objectives****3.1 NASA Mission Objectives**

- | | | |
|-------|--|---|
| 3.1.1 | <u>Evaluate</u> the performance of a man-spacecraft system in a three-orbit mission. | 1 |
| 3.1.2 | <u>Evaluate</u> the effects of space flight on the astronaut. | 1 |
| 3.1.3 | <u>Obtain</u> the astronaut's opinions on the operational suitability of the capsule and supporting systems for manned space flight. | 1 |

3.2 Atlas Systems Flight Objectives

- | | | |
|-------|--|---|
| 3.2.1 | <u>Evaluate</u> Atlas booster performance in releasing the Mercury capsule at the prescribed orbital insertion conditions. | 1 |
| 3.2.2 | <u>Reconfirm</u> evaluation of the performance of the Abort Sensing and Implementation System. | 2 |
| 3.2.3 | <u>Reconfirm</u> determination of the magnitude of the sustainer/vernier residual thrust after cutoff. | 2 |
| 3.2.4 | <u>Obtain</u> confirmation data on the repeatability of the performance of all Atlas missile and ground systems | 2 |

4. DATA REQUIREMENTS

This section designates the data necessary to fulfill the Atlas systems objectives. These requirements are consistent with the requirements designated in References (f), (g), and (h) unless otherwise noted herein.

NASA data requirements for the Mercury capsule will be defined in References (b), (c), (d), and (g).

		Reference Test Objectives	Objective Priority
4.1	<u>External Data</u>		
	4.1.1 <u>Landline Data</u>		
	4.1.1.1 Data specified in Table 4-1. Strip charts, EA pen records, oscillographs and magnetic tape records.	3.2.1, 3.2.4	1 and 2
	4.1.2 <u>Mod III Guidance Station Data</u>		
	4.1.2.1 Radio Tracking Systems (RTS) magnetic tapes.	3.2.1	1
	4.1.2.2 Sanborn recordings of shutoff guidance discretes and steering commands.	3.2.1, 3.2.4	1 and 2
	4.1.2.3 GE synchronous time.	3.2.1	1
	4.1.2.4 All other RTS data except for above.	3.2.1	1
	4.1.2.5 Computer intermediate tapes.	3.2.1, 3.2.4	1 and 2
	4.1.2.6 Computer output tapes.	3.2.1	1
	4.1.2.7 Guidance computer plotter data.	3.2.1	1

Reference Test Objectives	Objective Priority
---------------------------------	-----------------------

4.1.3 AMR Radar Tracking Data

4.1.3.1	Metric data suitable for determining	3.2.1	1
----------------	---	--------------	----------

range, range rate, lateral rate and position from liftoff until end of flight or to the limits of tracking system. This will specifically include the following AMR Mark II Azusa tracking data:

A. IBM 729 tape containing raw Azusa MK II data* t, l, m, r_m , l_c , m_c and r_c at the rate of 20 data points per second covering the following periods,

1. T-2 day calibrations
2. T-3 or 4 hour preflight calibration
3. Postflight calibrations.

The postflight calibrations will be readings of at least 10 seconds on each of the close-in poles plus a series of readings on the Kilofoot pole at decreasing signal strength from -60 dbw down to -140 dbw in 5 db steps.

4. The flight from launch to the end of tracking

*See Table A-2 in Appendix A for definition of Azusa MK II Tracking Data Abbreviations.

<u>Reference</u> <u>Test</u> <u>Objectives</u>	<u>Objective</u> <u>Priority</u>
--	-------------------------------------

- B. IBM 729 tape containing position, velocity and acceleration flight data. This data will be expressed in Cartesian coordinates having for origin the launch pad and the planned launch azimuth as the X axis.

4.1.4 AMR Optical Tracking Data

- | | | | |
|---------|--|-------|---|
| 4.1.4.1 | Engineering sequential motion picture data, preferably both color and black and white, for 360° coverage of the missile during engine start and liftoff. | 3.2.4 | 2 |
| 4.1.4.2 | Engineering sequential motion picture data, preferably both color and black and white, for coverage of the missile and propulsion exhaust plumes from liftoff through staging or the limit of tracking system. | 3.2.4 | 2 |
| 4.1.4.3 | Metric camera data suitable for determining missile acceleration during the first 300 feet of travel. | 3.2.4 | 2 |
| 4.1.4.4 | Metric camera data suitable for determining missile position and velocity from liftoff to the end of powered flight or the limit of the tracking system. | 3.2.4 | 2 |

		<u>Reference Test Objectives</u>	<u>Objective Priority</u>
4.1.5	<u>Range Safety Data</u>		
4.1.5.1	Records of all transmitted RSC signals, radar plotting charts, and signal strength records,	3.2.4	2
4.1.6	<u>Weather Data</u>		
4.1.6.1	Atmospheric data suitable for determining the surface index of refraction.	3.2.1	1
4.1.6.2	Weather forecasts as well as atmospheric data specified in Paragraph 6.13 and in Reference (f).	3.2.1, 3.2.4	1 and 2
4.1.7	<u>AMR Time</u>		
4.1.7.1	AMR time correlation of data records.	All	1 and 2
4.1.8	<u>Propellant Loading System Data</u>		
	Time event history of GD-A PLCU system, the fuel totalizer, and load cell data from initiation of tanking to launch.	3.2.4	2

<u>Reference</u> <u>Test</u> <u>Objectives</u>	<u>Objective</u> <u>Priority</u>
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4.2 Internal Data**4.2.1 Telemetry Reception**

4.2.1.1	Recording of data shown in Table 4-3 from T-30 seconds until loss of signal. 100 percent backup is required during powered flight.	As specified in Table 4-3	1 and 2
4.2.1.2	Center frequency of each telemetry link.	All	1 and 2
4.2.1.3	Signal strength at input to each ground station receiver.	All	1 and 2

TABLE 4-1 - 109D LANDLINE INSTRUMENTATION
(Reference Test Objectives 3.2.1 and 3.2.4)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
D*	5138	W*	Command No. 1 Battery	M*	0	60	Min
D	5139	W	Command No. 2 Battery	M	0	60	Min
D	5140	W	Command No. 1 Total	M	0	1000	Hr
D	5141	W	Command No. 2 Total	M	0	1000	Hr
D	5145	W	Accessory Total	M	0	1000	Hr
D	1357	X	TCC RS Int and Armed	R	Off	On	VDC
E	5066	C	Missile DC Amps	M	0	200	Amp
E	5068	C	Emergency Generator	M	0	200	Amp
E	5005	Q	Inverter Frequency	M	350	450	CPS
E	5029	Q	Missile Ext Phase A	M	350	450	CPS
E	5031	Q	Phase A Ext at MSL	M	396	404	CPS
E	5003	V	Battery Output	M	15	35	VDC
E	1006	V	Inverter Phase A	S	90	140	VAC
E	5006	V	Inverter Phase A	M	90	140	VAC
E	5022	V	Missile AC Ext at MSL	M	110	120	VAC
E	5023	V	Missile External AC	M	110	120	VAC

* Symbol identification presented in Appendix A.

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
E	5030	V	Missile DC Ext at MSL	M	0	40	VDC
E	5065	V	Missile External DC	M	0	40	VDC
E	5101	V	Ground DC BUS	M	0	30	VDC
E	5102	V	Missile DC BUS	M	0	30	VDC
E	1049	X	TCC PWR RDY LT	R	Off	On	VDC
F	1001	P	Lox Tank Helium	S	0	45	PIA
F	5001	P	Lox Tank Helium	M	0	30	PIA
F	1003	P	Fuel Tank Helium	S	0	100	PIA
F	5003	P	Fuel Tank Helium	M	0	100	PIG
F	5032	P	LN2 Pressure	M	0	400	PIG
F	5053	P	Norm Sup Pressure	M	0	4000	PIG
F	5054	P	Emerg Sup Pressure	M	0	4000	PIG
F	5116	P	Differential Press	M	0	5	PID
F	1125	P	B CTL Pneu Reg Out	S	0	1000	PIA
F	1194	P	Facility GN2 Supply	S	0	2500	PIA
F	1246	P	B TK HE BTL HI	S	0	3500	PIA
F	5246	P	B TK HE BTL HI	M	0	3500	PIA
F	1288	P	ST Pneu Reg Out	S	0	800	PIA

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
F	1291	P	S CTL HE BTL HI	S	0	3500	PIA
F	1301	P	GND Lox Ullage Tank	S	20	30	PIG
F	1302	P	GND Fuel Ullage Tank	S	55	65	PIG
F	5247	T	B TK HE Bottles	M	M400	M250	DGF
F	1207	X	TCC Intl Pneu P Lite	R	Off	On	VDC
G	1026	V	Pitch Analog	D	M30	30	VDC
G	1027	V	Yaw Analog	D	M30	30	VDC
H	1101	X	TCC Intl Hyd P Light	R	Off	On	VDC
H	1146	X	B Hyd Hi Press Sw	R	Off	On	VDC
H	1147	X	S Hyd Hi Press Sw	R	Off	On	VDC
H	1187	X	BSTR Oil Evacuation	R	Off	On	VDC
H	1188	X	Sust Oil Evacuation	R	Off	On	VDC
L	5006	D	Missile Alignment	M	M50	50	Min
L	1127	P	Holddown Cyl B1 Side	0	0	6500	PIA
L	1128	P	Holddown Cyl B2 Side	0	0	6500	PIA
M	1030	X	MSL Two Inch Motion	OR	Off	On	VDC

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
M	1050	X	MSL 42 Inch Motion	R	Off	On	VDC
M	1176	X	ASIS Ready	R	Off	On	VDC
N	5362	D	36 Inch Water Valve	M			
N	1342	T	POD Air Duct	S	0	200	DGF
N	1344	T	Transfer Room	S	0	100	DGF
N	1353	T	THST Sect HTR Output	S	0	250	DGF
N	1343	X	POD Air Duct Valve	R	Off	On	VDC
N	1354	X	KECO Airflow Sail SW	R	Off	On	VDC
P	5242	B	Pump LC Speed	M	0	100	PCT
P	5251	D	LC Throttle Valve	M	0	Full	
P	5685	M	Fuel in Missile	M	0	10K	GAL
P	1439	O	S NAA RCC Accel	4	M80	80	G
P	1452	O	B1 NAA RCC Accel	5	M80	80	G
P	1453	O	B2 NAA RCC Accel	6	M80	80	G
P	1893	O	B1 NAA Accel BK U	8	M80	80	G
P	1894	O	B2 NAA Accel BK U	9	M80	80	G
P	1006	P	S Thrust Chamber	0	0	1000	PIA

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
P	1026	P	B Lox REG Reference	S	0	800	PIA
P	1059	P	B2 Thrust Chamber	0	0	600	PIA
P	1060	P	B1 Thrust Chamber	0	0	600	PIA
P	1344	P	S Lox REG Reference	S	0	1000	PIG
P	5373	P	Lox Storage Tank	M	0	50	PIG
P	5430	P	Fuel Storage Tank	M	0	10	PIG
P	1017	T	B2 Turbine Inlet	S	500	1500	DGF
P	1021	T	Lox at Breakaway Vlv	S	M325	M275	DGF
P	1326	T	S Turbine Inlet	S	500	1500	DGF
P	1673	T	B1 Fuel Ign Vlv Amb	S	0	300	DGF
P	1674	T	B2 Fuel Ign Vlv Amb	S	0	300	DGF
P	1675	T	Eng CTL Pneu Man	S	0	300	DGF
P	1437	W	S RCC Binary Count	2	0	100	MS
P	1454	W	B1 RCC Binary Count	4	0	100	MS
P	1455	W	B2 RCC Binary Count	6	0	100	MS
P	1897	W	B1 RCC Bin Count BKU	8	0	100	MS
P	1898	W	B2 RCC Bin Count BKU	10	0	100	MS

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
P	1067	X	B2 Lox Vlv Clsd MSW	R	On	Off	VDC
P	1068	X	B1 Lox Vlv Clsd MSW	R	On	Off	VDC
P	1069	X	B2 Fuel Vlv Clsd MSW	R	On	Off	VDC
P	1070	X	B1 Fuel Vlv Clsd MSW	R	On	Off	VDC
P	1071	X	B GG Vlv Closed MSW	R	On	Off	VDC
P	1073	X	V1 PV Closed MSW	R	On	Off	VDC
P	1074	X	V2 PV Closed MSW	R	On	Off	VDC
P	1077	X	Vernier Cutoff Relay	R	On	Off	VDC
P	1137	X	ETP Prep Complete LT	R	On	Off	VDC
P	1147	X	B GG Vlv Open MSW	R	On	Off	VDC
P	1154	X	TCC B Engine Cof SW	R	On	Off	VDC
P	1155	X	Observer Cutoff	R	On	Off	VDC
P	1157	X	B2 TBN OVSPEED TRIP	R	On	Off	VDC
P	1158	X	Prep Incomplete COF	R	On	Off	VDC
P	1161	X	TCC Start Switch	R	On	Off	VDC
P	1164	X	TCC Vern Eng COF SW	R	On	Off	VDC
P	1169	X	B2 Lox Vlv Open MSW	R	On	Off	VDC

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
P	1170	X	B1 Lox Vlv Open MSW	R	On	Off	VDC
P	1172	X	V1 PV Open MSW	R	On	Off	VDC
P	1174	X	V2 PV Open MSW	R	On	Off	VDC
P	1192	X	B1 Rough Comb COF	R	On	Off	VDC
P	1193	X	B2 Rough Comb COF	R	On	Off	VDC
P	1194	X	B1 Fuel Vlv Open MSW	R	On	Off	VDC
P	1195	X	B2 Fuel Vlv Open MSW	R	On	Off	VDC
P	1198	X	S Lox HSV Open MSW	R	On	Off	VDC
P	1199	X	S Lox HSV Clsd MSW	R	On	Off	VDC
P	1202	X	S Fuel PUV Open MSW	R	On	Off	VDC
P	1203	X	S Fuel PUV Clsd MSW	R	On	Off	VDC
P	1311	X	90% Fuel Lvl Ind	R	Off	On	VDC
P	1335	X	SGG Vlv Clsd MSW	R	Off	On	VDC
P	1347	X	S Cutoff Relay	R	Off	On	VDC
P	1438	X	S Rough Comb COF	R	Off	On	VDC
P	1441	X	Ignition Stage Timer	R	Off	On	VDC
P	1445	X	B Fuel Pre Vlv Open	R	Off	On	VDC

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
P	1446	X	B Fuel Pre Vlv Clsd	R	Off	On	VDC
P	1499	X	SGG Vlv Open MSW	R	Off	On	VDC
P	1566	X	DC Gnd Pwr Fail COF	R	Off	On	VDC
P	1575	X	Pre Start Ready	R	Off	On	VDC
P	1577	X	Release Signal	R	Off	On	VDC
P	1580	X	S Fuel Pre Vlv Clsd	R	Off	On	VDC
P	1581	X	S Fuel Pre Vlv Open	R	Off	On	VDC
P	1588	X	S TBN Overspeed Trip	R	Off	On	VDC
P	1592	X	Booster Eng Cutoff	R	Off	On	VDC
P	1593	X	Sustainer Eng Cutoff	R	Off	On	VDC
P	1594	X	TCC Sustainer COF SW	R	Off	On	VDC
P	1596	X	Pre-Rls COF Disarm	R	Off	On	VDC
P	1598	X	Vernier Engine Cutoff	R	Off	On	VDC
P	1608	X	Eng Tanks Pres	R	Off	On	VDC
P	1609	X	Eng Fuel Tk Press	R	Off	On	VDC
P	1610	X	Eng Lox Tk Press	R	Off	On	VDC
P	1611	X	Main Ignition Start	R	Off	On	VDC

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
P	1612	X	GG Ign Link Pilot	R	Off	On	VDC
P	1613	X	V1 P Chm Switch On	R	Off	On	VDC
P	1614	X	V2 P Chm Switch On	R	Off	On	VDC
P	1616	X	B Flight Lockin	R	Off	On	VDC
P	1617	X	Main Stage Limiter	R	Off	On	VDC
P	1618	X	B1 Fuel Man P Sw On	R	Off	On	VDC
P	1619	X	B2 Fuel Man P Sw On	R	Off	On	VDC
P	1621	X	Ign Stage Vlvs	R	Off	On	VDC
P	1621	X	Ign Stage Vlvs	O	Off	On	VDC
P	1622	X	S Flight Lockin	R	Off	On	VDC
P	1623	X	S Fuel Man P Sw On	R	Off	On	VDC
P	1624	X	Main Eng Complete	R	Off	On	VDC
P	1627	X	Main Eng Th Complete	R	Off	On	VDC
P	1628	X	Ign Stage Lim Cof	R	Off	On	VDC
P	1630	X	Main Stage Lim Cof	R	Off	On	VDC
P	1631	X	Lox F and D Vlv Airb Opn	R	Off	On	VDC
P	1632	X	Lox F and D Vlv Airb Cls	R	Off	On	VDC

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
P	1633	X	Lox F and D Vlv Gnd Opn	R	Off	On	VDC
P	1634	X	Lox F and D Vlv Gnd Cls	R	Off	On	VDC
P	1635	X	Ful F and D Vlv Airb Opn	R	Off	On	VDC
P	1636	X	Ful F and D Vlv Airb Cls	R	Off	On	VDC
P	1637	X	Ful F and D Vlv Gnd Opn	R	Off	On	VDC
P	1638	X	Ful F and D Vlv Gnd Cls	R	Off	On	VDC
P	1639	X	Engine Reset	R	Off	On	VDC
P	1686	X	B and SGG Lox Purge	R	Off	On	VDC
P	1687	X	B and SGG Fuel Purge	R	Off	On	VDC
P	1755	X	Ful at Missile Light	R	Off	On	VDC
P	1756	X	4 Sec Cutoff TMR DO	R	Off	On	VDC
P	1936	X	Lox TOPG Level Low	R	Off	On	VDC
P	1937	X	Lox TOPG Level Hi	R	Off	On	VDC
P	1975	X	B1 Rcc Backup Relay	R	Off	On	VDC
P	1976	X	B2 Rcc Backup Relay	R	Off	On	VDC
P	1987	X	Fuel Overfill Probe	R	Off	On	VDC

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TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
P	1988	X	Lox 95% Lvl Emer Cof	R	Off	On	VDC
P	1997	X	MSL Fueled 95%	R	Off	On	VDC
P	1998	X	Lox 0/Fill Emerg Cof	R	Off	On	VDC
P	1999	X	MSL Fueled 100%	R	Off	On	VDC
S	5281	C	Panel Power Supply	M	0	400	MA
S	1048	V	Programmer Pitch Sig	D	0	2.7	VAC
S	1049	V	Programmer Roll Sig	D	0	60	VAC
S	1107	V	B1 PCH ACTR Feedback	D	M12	12	VAC
S	1108	V	B2 PCH ACTR Feedback	D	M12	12	VAC
S	1113	V	V1 Yaw ACTR Feedback	D	M5	7	VAC
S	1114	V	V2 Yaw ACTR Feedback	D	M5	7	VAC
S	1118	V	V2 PCH ACTR Feedback	D	M11	11	VAC
S	1119	V	V1 PCH ACTR Feedback	D	M11	11	VAC
S	1121	V	Gyro Test Sig	D	M5	5	VAC
S	1122	V	Servo Test Sig	D	M11	11	VAC
S	1123	V	Integrator Test Sig	D	M11	11	VAC
S	1128	V	B1 Yaw ACTR Feedback	D	M12	12	VAC

TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
S	1129	V	B2 Yaw ACTR Feedback	D	M12	12	VAC
S	1147	V	Pitch Gyro Amp Out	D	M10	10	VAC
S	1148	V	Yaw Gyro Amp Out	D	M10	10	VAC
S	1149	V	Roll Gyro Amp Out	D	M10	10	VAC
S	1216	V	S PCH ACTR Feedback	D	M10	10	VAC
S	1217	V	S Yaw ACTR Feedback	D	M10	10	VAC
S	5270	V	Fine Heater-Pitch	M	0	150	VAC
S	5271	V	Fine Heater-Yaw	M	0	150	VAC
S	5272	V	Fine Heater-Roll	M	0	150	VAC
S	5280	V	Panel Power Supply	M	0	200	VDC
S	5176	W	Program Run Time	M	0	999	SEC
S	5282	W	Decade Event Timer	M	0	10K	SEC
S	1235	X	Programmer Run Time	R	Off	On	VDC
S	1356	X	TCC Autopilot Rdy Lt	R	Off	On	VDC
S	1396	X	Programmer Reset	R	Off	On	VDC
T	5142	W	Telemeter Battery	M	0	60	MIN
T	5143	W	Telemeter Total	M	0	1000	HR

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TABLE 4-1. 109D LANDLINE INSTRUMENTATION (continued)

System	Measurement No.	Type Measurement	Description	Type Recorder	Range		Unit
					Low	High	
U	1107	C	PU SV Amp Out	D	M5	5	MA
U	1091	V	Error Ratio Demod Op	S	M20	20	VDC
U	5091	V	Lox Tank Level Ind	M	80	105	PCT

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TABLE 4-2 - GO/NO-GO LANDLINE REQUIREMENTS*

F1001P	Lox Tank Helium Pressure
F1003P	Fuel Tank Helium Pressure
F1125P	Booster Control Regulator Pressure
F1246P	Booster Helium Bottle Pressure
F1288P	Start Tank Regulator Pressure
F1291P	Sustainer Control Bottle Pressure
F5247T	Booster Helium Bottle Temperature
L1127P	Holddown Cyl B1 Side
L1128P	Holddown Cyl B2 Side
M1176X	ASIS Ready
P1017T	Booster No. 2 Turbine Inlet Temperature
P1326T	Sustainer Turbine Inlet Temperature
P1026P	Booster Lox Regulator Reference Pressure
P1344P	Sustainer Lox Regulator Reference Pressure
U1091V	Error Ratio Demodulator Output

* Refer to paragraph 6.7 for definition of Go/No Go Landline Requirements.

TABLE 4-3 - ATLAS TELEMETRY DATA REQUIREMENTS

Measurement No.	Description	TLM/Channel/Pin No.		Measurement Range			Reference	
				Low	High	Units	Test Objective	
E 50 Q	400 Cycle AC Power Supply	1	1	370	430	CPS	3.2.2, 3.2.4 (M)*	
P 84 B	B1 Pump Speed	1	2	4580	5320	RPM	3.2.4 (R)*	
P 349 B	S Pump Speed	1	3	9.9	11.2	KPM	3.2.4 (R)	
F 1 P	Lox Tank Helium	1	4	0	45	PIA	3.2.2, 3.2.4 (M)	
S 362 R	Yaw Gyro Back-up	1	5	M8	8	D/S	3.2.1, 3.2.2 (R)	
S 252 D	B1 Yaw Roll	1	6	M7	7	DEG	3.2.1, 3.2.4 (R)	
M 79 A	Msl Axial Accel Fine	1	6	M.5	.5	G	3.2.3 (R)	
S 363 R	Pitch Gyro Back-up	1	7	M8	8	D/S	3.2.1, 3.2.2 (R)	
S 54 R	Yaw Rate Gyro Sig	1	8	M9	9	D/S	3.2.1, 3.2.2, 3.2.4 (M)	
D 3 X	RSC Destruct Output	1	C	0	30	VDC	3.2.4 (M)	
S 53 R	Pitch Rate Gyro Sig	1	9	M9	9	D/S	3.2.1, 3.2.2, 3.2.4 (M)	
S 52 R	Roll Rate Gyro Sig	1	10	M11	11	D/S	3.2.1, 3.2.2, 3.2.4 (M)	
S 393 W	Programmer Clock Out	1	11	0	13	V	3.2.4 (M)	
U 101 A	Axial Acceleration	1	12	0	8	G	3.2.4 (M)	
A 110 P	Adapt Ext. Dynamic P	1	13	M1.4	1.4	PIG	3.2.4 (R)	
Comm. Rate 10 RPS								
M 91 X	2 Inch Motion 28V	1	A	1	Off	On	VDC	3.2.2 (M)
G 3 V	PB AGC	1	A	3	M6	0	VDC	3.2.1 (M)
M 133 X	Booster Staging	1	A	5	Off	On	VDC	3.2.4 (M)
A 828 D	Manhole Cov-Retropkg	1	A	7	M1	1	IN	3.2.4 (R)
H 310 P	S Eng Ctl Hyd Press	1	A	9	0	3500	PIA	3.2.4 (R)
S 394 X	A/P 2 In Plus 30 Sec	1	A	11	Off	On	VDC	3.2.4 (M)
F 3 P	Fuel Tank Helium	1	A	13	0	100	PIA	3.2.4 (M)
H 52 P	S Hyd Accumulator	1	A	15	0	3500	PIA	3.2.4 (R)
P 77 X	Vernier Cutoff Relay	1	A	17	Off	On	VDC	3.2.4 (M)
P 616 X	B Flight Lockin	1	A	19	Off	On	VDC	3.2.4 (M)
G 4 C	PB Magnetron Average	1	A	21	0	1.6	MA	3.2.1 (R)
G 287 Y	D Pitch Output	1	A	23	0	20	PRV	3.2.1 (R)
G 288 Y	D Yaw Output	1	A	29	0	20	PRV	3.2.1 (R)
G 279 V	RB AGC No 1	1	A	31	M7.3	0	VDC	3.2.1 (M)
G 290 X	D Contacts No 1 and No 2	1	A	33	Off	On	VDC	3.2.1 (R)
M 28 X	Abort System Signal	1	A	35	Off	On	VDC	3.2.2 (M)
A 828 D	Connected to 1 A 7	1	A	37	Off	On	VDC	3.2.4 (M)
P 574 X	Sus Inj Man P SW	1	A	39	Off	On	VDC	3.2.2 (M)
S 179 X	VCO-Abort Sys Output	1	A	41	Off	On	VDC	3.2.2 (M)
E 34 X	AC Low Voltage	1	A	43	Off	On	VDC	3.2.2 (M)
P 300 X	B1 Inj Man Pr SW	1	A	45	Off	On	VDC	3.2.2 (M)

*Symbol identification presented in Appendix A

TABLE 4-3 - ATLAS TELEMETRY DATA REQUIREMENTS (continued)

Measurement No.	Description	TLM/Channel/Pin No.			Measurement Range			Reference Test Objective
					Low	High	Units	
F 132 X	Lox Tk Press Sw	1	A	47	Off	On	VDC	3.2.2 (M)
G 82 E	RB RF Output	1	A	49	0	15	E	3.2.1 (R)
F 133 X	Delta P Switch	1	A	51	Off	On	VDC	3.2.2 (M)
F 152 X	BCO-Lox Tk Press SW	1	A	53	Off	On	VDC	3.2.2 (M)
P 313 X	B2 Inj Man Pr SW	1	A	55	Off	On	VDC	3.2.2 (M)
Comm. Rate 10 RPS								
D 1 V	RSC Cutoff Output	1	C	1	0	30	VDC	3.2.4 (M)
H 220 X	S Hyd P SW	1	C	3	Off	On	VDC	3.2.2 (M)
D 7 V	No 1 RSC RF Input/AGC	1	C	5	15	100K	UV	3.2.4 (R)
P 83 B	B2 Pump Speed	1	C	7	4580	5320	RPM	3.2.4 (R)
U 80 P	Lox Tank Head	1	C	9	0	5	PID	3.2.4, 3.2.1 (M)
U 81 P	Fuel Tank Head	1	C	11	0	5	PID	3.2.4, 3.2.1 (M)
E 28 V	Msl Systems Input	1	C	13	0	35	VDC	3.2.2, 3.2.4 (M)
P 100 P	B GO Combustion Chm	1	C	15	0	600	PLA	3.2.4 (R)
S 257 D	Sustainer Pitch	1	C	17	M4.5	4.5	DEG	3.2.1, 3.2.4 (R)
S 254 D	B1 Pitch	1	C	19	M7	7	DEG	3.2.1, 3.2.4 (R)
H 33 P	B1 Hyd Accumulator	1	C	21	0	3500	PLA	3.2.4 (R)
D 120 X	Destruct Enable	1	C	23	0	2.4	VDC	3.2.4 (M)
P 339 P	S Gas Gen Disch	1	C	29	0	800	PLA	3.2.4 (R)
F 246 P	B Tk He Bottles Hi	1	C	31	0	3500	PLA	3.2.4 (R)
E 51 V	400 Cycle AC Phase A	1	C	33	85	125	VAC	3.2.4 (M)
P 528 D	S Main Fuel Vlv	1	C	35	0	90	DEG	3.2.4 (R)
U 91 V	Error Ratio Demod Op	1	C	37	M20	20	VDC	3.2.2 (R)
P 6 P	S Thrust Chamber	1	C	39	0	1000	PLA	3.2.4 (M)
P 59 P	B2 Thrust Chamber	1	C	41	0	600	PLA	3.2.2, 3.2.4 (M)
P 60 P	B1 Thrust Chamber	1	C	43	0	600	PLA	3.2.2, 3.2.4 (M)
F 291 P	S Ctl He Btl	1	C	45	0	3500	PLA	3.2.4 (R)
S 257 D	Connected to 1 C 17	1	C	47	M4.5	4.5	DEG	3.2.1, 3.2.4 (R)
S 254 D	Connected to 1 C 19	1	C	49	M7	7	DEG	3.2.1, 3.2.4 (R)
P 28 P	V1 Thrust Chamber	1	C	51	0	400	PLA	3.2.4 (R)
P 29 P	V2 Thrust Chamber	1	C	53	0	400	PLA	3.2.4 (R)
P 14 T	Engine Comp Ambient	1	C	55	0	600	DGF	3.2.4 (R)
S 255 D	B2 Pitch	1	E	1	M5	5	DEG	3.2.1, 3.2.4 (R)
F 119 P	Inter Bulkhead Dp	1	E	3	0	30	PID	3.2.2 (R)
A 993 A	Pitch Accel	1	E	5	M2	2	G	3.2.4 (R)
S 258 D	V1 Pitch Roll	1	E	7	M70	70	DEG	3.2.1, 3.2.4 (R)
S 253 D	B2 Yaw Roll	1	E	9	M5	5	DEG	3.2.1, 3.2.4 (R)
F 116 P	Differential Press	1	E	11	0	30	PID	3.2.2 (M)

TABLE 4-3 - ATLAS TELEMETRY DATA REQUIREMENTS (continued)

Measurement No.	Description	TLM/Channel/Pin No.			Measurement Range			Reference
					Low	High	Units	Test Objective
Comm. Rate 10 RPS								
S 256 D	Sustainer Yaw	1	E	15	M4.5	4.5	DEG	3.2.1, 3.2.4 (R)
A 993 A	Connected to 1 E 5	1	E	17				3.2.4 (R)
S 259 D	V2 Pitch Roll	1	E	21	M70	70	DEG	3.2.1, 3.2.4 (R)
F 119 P	Connected to 1 E 3	1	E	23				3.2.2 (R)
A 993 A	Connected to 1 E 17	1	E	29				3.2.4 (R)
F 116 P	Connected to 1 E 11	1	E	31				3.2.2 (M)
S 61 D	Roll Displ Gyro Sig	1	E	33	M3	3	DEG	3.2.1, 3.2.4 (R)
S 62 D	Pitch Displ Gyro Sig	1	E	35	M3	3	DEG	3.2.1, 3.2.4 (R)
S 63 D	Yaw Displ Gyro Sig	1	E	37	M3	3	DEG	3.2.1, 3.2.4 (R)
Y 147 P	Adapter Area AMB P	1	E	39	0	15	PIA	3.2.4 (R)
A 993 A	Connected to 1 E 29	1	E	41				3.2.4 (R)
F 119 P	Connected to 1 E 23	1	E	43				3.2.2 (R)
S 256 D	Connected to 1 E 15	1	E	45				3.2.1, 3.2.4 (R)
P 55 P	S Fuel Pump Inlet	1	E	47	0	120	PIA	3.2.1, 3.2.4 (R)
P 56 P	S Lox Pump Inlet	1	E	49	0	150	PIA	3.2.1, 3.2.4 (R)
F 116 P	Connected to 1 E 31	1	E	51				3.2.2 (M)
A 993 A	Connected to 1 E 41	1	E	53				3.2.4 (R)
F 1 P	Lox Tank Helium	1	E	55	0	45	PIA	3.2.2, 3.2.4 (M)
	Synd and 100% Calib	1	E	56				
	Connected to 1 E 55	1	E	56				

TABLE 4-4 - GO/NO-GO TELEMETRY LIST

<u>MEASUREMENT NUMBER</u>	<u>DESCRIPTION</u>
<u>Subsystem Functions</u>	
D1V	RSC Cutoff Output
D3X	RSC Destruct Output
E50Q	400 Cycle AC Pwr Sup
E28V	MSL Systems Input
E51V	400 Cycle AC Phase A
F1P	Lox Tank Helium
F3P	Fuel Tank Helium
F116P	Differential Pressure
G3V	Pulse Beacon AGC
G279V	Rate Beacon AGC No.1
M91X	2 Inch Motion 28V
P6P	S Thrust Chamber
P59P	B ₂ Thrust Chamber
P60P	B ₁ Thrust Chamber
P77X	Vernier Cutoff Relay
S393W	Programmer Clock Out
S394X	A/P Two Inch + 30 Seconds
S179X	VCO-Abort Sys Output
U101A	Axial Acceleration
U80P	Lox Tank Head
U81P	Fuel Tank Head
<u>ASIS Functions</u>	
E34X	AC Low Voltage
E152X	BCO-Lox Tank Press SW
F132X	Lox Tank Press SW
F133X	Delta P Switch

MEASUREMENT NUMBERDESCRIPTION

H220X	S Hyd Press SW
M28X	Abort System Signal
P300X	B ₁ Inj Man PR SW
P313X	B ₂ Inj Man PR SW
P574X	Sys Inj Man PR SW
S52R	Roll Rate Gyro Sig
S53R	Pitch Rate Gyro Sig
S54R	Yaw Rate Gyro Sig

5. TEST CONFIGURATION

5.1 NASA Capsule Systems

A production Mercury Capsule (No. 13), with accommodations for the astronaut, and an active escape system will be used for MA-6. The configuration and operation of the individual capsule systems will be as specified in References (b), (c) and (d).

5.2 Atlas Systems

Atlas Series D Mercury Space-Booster No. 109D will be used to boost the capsule to the required free-flight conditions. This is the second* Mercury/Atlas booster vehicle completed during regular factory assembly run with heavier forward tank skins (88D and 93D factory refurbished vehicles). Propellant tank skin gauges are as presented in Table 5-1. This vehicle does not differ from the previous booster (93D) in any major respect. Booster vehicle engine nomenclature has been redesignated as the MA-5 Space-Booster engine system. There are no significant hardware differences between the MA-5 system installed on 109D and the MA-2 booster engine system installed on previous Atlas Vehicles.

The general configuration of the individual Atlas systems is described below; detailed descriptions are presented in Reference (e).

5.2.1 Airframe

GD-A Series D Atlas Airframe Structure with following significant elements:

- a. "C" type Peacock lox boiloff valve.
- b. Forward rate gyro pod installed
- c. Protective skull cap insulation added to top of liquid oxygen tank dome and boiloff valve ducting.

* 100D was the first.

- d. Low pressure drop sustainer pump inlet lox ducting and lox staging disconnect.
- e. Propellant tank skin gauges have been modified by increasing skin gauge and are as presented in Table 5-1.

NOTE: (To allow for future identification of photographic records, the vehicle number will be painted in 14-inch high letters at the base of the fuel tank on the centerline of Quad I-II and Quad III-IV.)

5.2.2 Electrical

GD-A rotary inverter system utilizing a Bendix inverter, a power change-over switch and using a remotely activated battery (Figure 5-1),

5.2.3 Flight Control

GD-A modified* AIG type autopilot system. Autopilot control rate gyros are located at Station 675; position gyros are located at Station 975. Gyro spin motor monitors will be employed. The autopilot requires both AC and DC missileborne power. Figure 5-2 is a simplified circuitry diagram of the Flight Control System and its instrumentation assignment locations.

* Modifications consist of incorporation of the following:

- (a) ECP 1370, to eliminate the effect of electrical transients on A/P programmer by use of filters, diodes, wiring changes, etc.
- (b) Flight Programmer Filter Time Slot Network. 109D will be the second booster vehicle (93D first) to have the Flight Control Programmer modified to include a switching change of already existing filters. This change will provide a 0-20 second time slot for inclusion of the 4+3 cps filter network in place of the 4+8 cps compensating filter network previously effective through this time period. This change was incorporated to eliminate the 10 cps oscillation noted on the MA-4 (88D) flight during the period of from 1.25 to 19 seconds after launch.
- (c) ECP 1370-R-1, increases certain programmer resistor wattage and clears programmer of unreliable types of transistors.

5.2.4 Guidance

General Electroc Mod IIIA radio guidance system; consisting of a pulse beacon, rate beacon (modified in accordance with ECPs 313 and 316) and decoder (modified in accordance with ECP 310), with traveling wave-slot type antennas mounted at a 12-1/2 degree angle with respect to the pod to provide improved "look angle," for the guidance tracking radar. The guidance system utilizes missile AC power. A simplified block diagram of the guidance and tracking information flow between the flight vehicle and the ground network is shown in Figure 5-3. The ASCO signal path has been modified to by pass the autopilot programmer and go directly from the RSC receiver to the engine relay box. This change was made to prevent a failure in the autopilot programmer from disabling the ASCO engine cutoff capabilities.

5.2.5 Hydraulic

The hydraulic system (Figure 5-4) is identical to the standard Atlas D system with the vernier solo package deleted. The system is composed of two independent sections, one supplying power for the sustainer, and the other for the booster portion of the vehicle. Hydraulic power is used for positioning the booster, sustainer, and vernier engines and controlling the sustainer propellant and gas generator valves.

5.2.6 Instrumentation

One Mercury lightweight FM/FM telemeter (3.5 watt) for Atlas systems data, using remotely activated battery. Figure 5-5 is a block diagram of the Booster Airborne Telemetry System. Figure 5-6 shows the telemetry commutated wave forms format.

5.2.7 Pneumatic

The pneumatic system (Figure 5-7) is the D series system using only specially selected Hadley "D" regulators for propellant tank pressurization. High pressure helium gas is used by the system for propellant tank pressurization, booster separation, and by the propulsion system for propulsion control. The pneumatic supply is broken into three sections. A set of five storage bottles is used for tank pressurization, a separate bottle for the engine controls, and a separate bottle for staging separation.

5.2.8 Propellant Loading

The GD-A loading system uses level sensors in the missile tanks and launcher load cells to achieve proper propellant tanking. Fuel level sensors are located at positions giving indication of 90%, 95%, 100%, and 100.2% of full. Lox level sensors are located at stations indicating 95%, 100%, 100% plus 600 lb, and 100.2% full. The lox level sensors at

100% and 100% plus 600 lbs are called the Level Lo and Level Hi probes respectively. Propellant loading control is used to provide the correct amount of fuel and lox for a flight without the penalties of excess propellants or incorrect ratio of propellants.

5.2.9 Propellant Utilization

GD-A Manometer system using both AC and DC power. This system measures fuel and lox mass with mercury manometers and through a control unit computes and controls the residual propellant mass ratio. A special capacitor is added to insure a lox rich signal after ports uncover. Figure 5-8 is a block diagram of the Atlas PU System.

5.2.10 Propulsion

- 5.2.10.1 Rocketdyne MA-5 system (Figure 5-9), consisting of Booster No. NA 115102, Sustainer No. NA 225102, and Vernier thrust chambers. The engines utilize DC power.

NOTE: (Vernier solo refill orifices, used to refill the vernier start tanks, have been plugged.)

- 5.2.10.2 RC filter networks have been added to the booster and sustainer vernier cutoff relay circuits to reduce the possibility of inadvertent engine cutoff resulting from spurious transients.
- 5.2.10.3 Two independent parallel rough combustion cutoff (RCC) systems for each booster thrust chamber and one RCC system on the sustainer are installed. For instrumentation purposes, the backup RCC accelerometers will be connected through 42-inch motion.
- 5.2.10.4 The Rocketdyne Engine Relay Box has been modified, utilizing existing components, to provide redundant engine cutoff circuitry. ECP MA-5-43 covers this modification.

- 5.2.10.5 RC Filter networks have been added to the booster and sustainer-vernier cutoff solenoids to reduce the magnitude of the electrical transients generated by the solenoids at actuation and deactuation and thus preclude inadvertent operation of electrical transient sensitive circuits in the flight control system.

5.2.11 Range Safety

- 5.2.11.1 Range Safety Command (RSC) system reference (Figure 5-10), consisting of two ARW-62 receivers (CVA 27-36014-1) and associated circuitry which has been modified to provide (1) a 3-second time delay between enabling at MFCO (manual fuel cut-off) which must be sent prior to destruct command and the initiation of destruct; (2) increased linearity and decreased gain of the tone amplifier in the Power and Control Unit.

Primary RSC frequency - 414 mc.

Power - One independent Yardney Lab actuated battery for each receiver.

COMMAND SEQUENCE

- (a) MFCO - Tones 1 and 5 for more than 100 milliseconds.
 - (b) Destruct - Tones 1 and 5 for at least 100 milliseconds followed by tone 1 alone for less than 1 millisecond followed by tones 1 and 2 for at least 3 seconds more than tones 1 and 5.
- 5.2.11.2 Azusa type B coherent carrier transponder, with flush-mounted, coaxial fed antenna.

Frequency: C Band

Power: 5-10 watts

Missile AC only

Azusa backup ASCO

The AMR IP 7090 computer will be programmed to use Azusa data input for generation of a backup ASCO command in case of guidance failure only. The ASCO backup capability will be under command control from the Mercury Control Center.

5.2.12 Abort Sensing and Implementation System (ASIS)

The system is composed of instrumentation within the Atlas booster to sense impending malfunction and to activate the capsule escape system (Figure 5-11 and Table 6-4). Power requirements are 400 cps, 115V AC and 28.0 VDC.

Critical parameters being monitored are: (1) Missile AC and DC Voltage (2) Attitude Rates (3) Lox Tank Pressure (4) Lox/Fuel tank differential pressure (5) Booster and Sustainer engine fuel injector pressure (6) Sustainer hydraulic pressure (7) Loss of capsule/booster electrical interface.

5.2.12.1 Changes to Basic ASIS System

The ASIS differential pressure restrictor in the lox head pressure sensing line has proven itself successful on MA-2 and MA-3 and will be carried as a permanent system modification. Particle filter screens have been added on either end of the restrictor. The following are the modifications to the Abort System resulting from the MA-3 review:

(a) Abort System Control Unit

- 1) Quad diode matrices have been added in parallel with the coil of all ASCU relays in order to suppress transients resulting from the in-flight operation of such relays.

- 2) For purposes of autopilot programmer instrumentation telemeter signal S394X has been added to monitor the 28-volt signal from the programmer to the ASCU at T + 30 seconds.

(b) ASIS Arm Relays

Both ASIS arming relays have been modified for transient suppression by the addition of quad diodes across the relay coil.

(c) ASIS Test Relays

A separate relay assembly has been integrated with the abort system to permit countdown test of ASIS at approximately T-90 seconds. This test provides added assurance that the ASIS is in a "GO" condition prior to engine start. This is desirable as a "NO GO" condition at engine start would result in a subsequent engine shut down.

Control and monitoring circuitry associated with this countdown test has been integrated with the existing blockhouse AGE.

(d) Missile Harness Changes

- 1) The Abort System arming function at 2-inch motion has been separated from the autopilot programmer arming function also occurring at 2-inch motion. A new umbilical wire has been assigned for use by the Abort System. No connection, either ground or missileborne, now exists with the autopilot programmer start function.

- 2) The T-0 function to the capsule is no longer routed through the autopilot programmer arm/safe switch in order to minimize the interface between the ASIS and the programmer.
 - 3) Control wiring to the ASIS Test Relays has been added to the missile harness terminating at umbilical plug P1001.
- (e) Complex 14 Test Conductor Abort Command

A redundant pushbutton switch and associated wiring is authorized for the "Test Conductor Abort" blockhouse circuitry. This was requested by NASA in order to improve the reliability of transmission of the Test Conductor Abort Command.

Modifications Introduced Since MA-4:

- (a) The lox tank ullage pressure switches PN 87-44900-372 and PN 87-44900-374, located in B₁ pod, have been replaced by PN 87-44900-356 and PN 87-44900-355 respectively. ECP 1389 covers this change.
- (b) The Abort System Control Unit has been modified to assure that if an abort condition occurs when a Zener diode in the output circuit of the 2 Not Gates in the ASCU is shorted, the voltage drop at the output circuits of the 2 Not Gates will be sufficient to assure dropout of the Booster failure detector relays in the capsule. Modified ASCU's carry a 27-11111-835 part number. ECP 1627 covers this modification.

This will be the fifth* closed loop flight of the Abort System. Five** open loop flights of the Abort System or of ASIS components have been completed.

5.3 Ground Equipment

5.3.1 Launch Complex

- 5.3.1.1 AMR Complex 14(28°29' 27" N, 80°32' 50" W).
Launcher azimuth - 104.977°T. Complex 14 is a standard "D" series complex with modifications to support the Mercury/Atlas "D" series booster.

5.3.2 Ground Guidance Station

- 5.3.2.1 GE/Burroughs Mod III system at Cape Canaveral.

5.3.3 Impact Predictor System

- 5.3.3.1 The Mark II Azusa system at Cape Canaveral.

5.4 AMR Test Support

It is recommended that the following AMR equipment be furnished to support the fulfillment of the data requirements specified in Section 4 of this document. The recommended equipment is identified with the data requirement it supports.

5.4.1 Radar Tracking Systems

- 5.4.1.1 FPS-16 C-band radars tracking from Stations 1 and 3 (4.1.3.1).
5.4.1.2 Mod II S-band radars (4.1.3.1).
5.4.1.3 Azusa C-band system tracking from Station 1 (4.1.3.1).

5.4.2 Optical Tracking Systems

- 5.4.2.1 Mitchell and Fastax Cameras (4.1.4.1).
5.4.2.2 ROTI and IGOR cameras (4.1.4.2).
5.4.2.3 Ribbon Frame cameras (4.1.4.3).
5.4.2.4 Cine-Theodolites (4.1.4.4).

* Closed loop - 67D, 100D, 88D and 93D

**Open loop - 56D, 62D, 50D, 32D and 79D

5.4.3 Telemetry Receiving Stations**5.4.3.1 Stations 1 and 3 (4.2.1.1).****5.5 Radiation Frequencies**

The frequencies of the various electronics systems to be used during this test are listed in Table 5-2.

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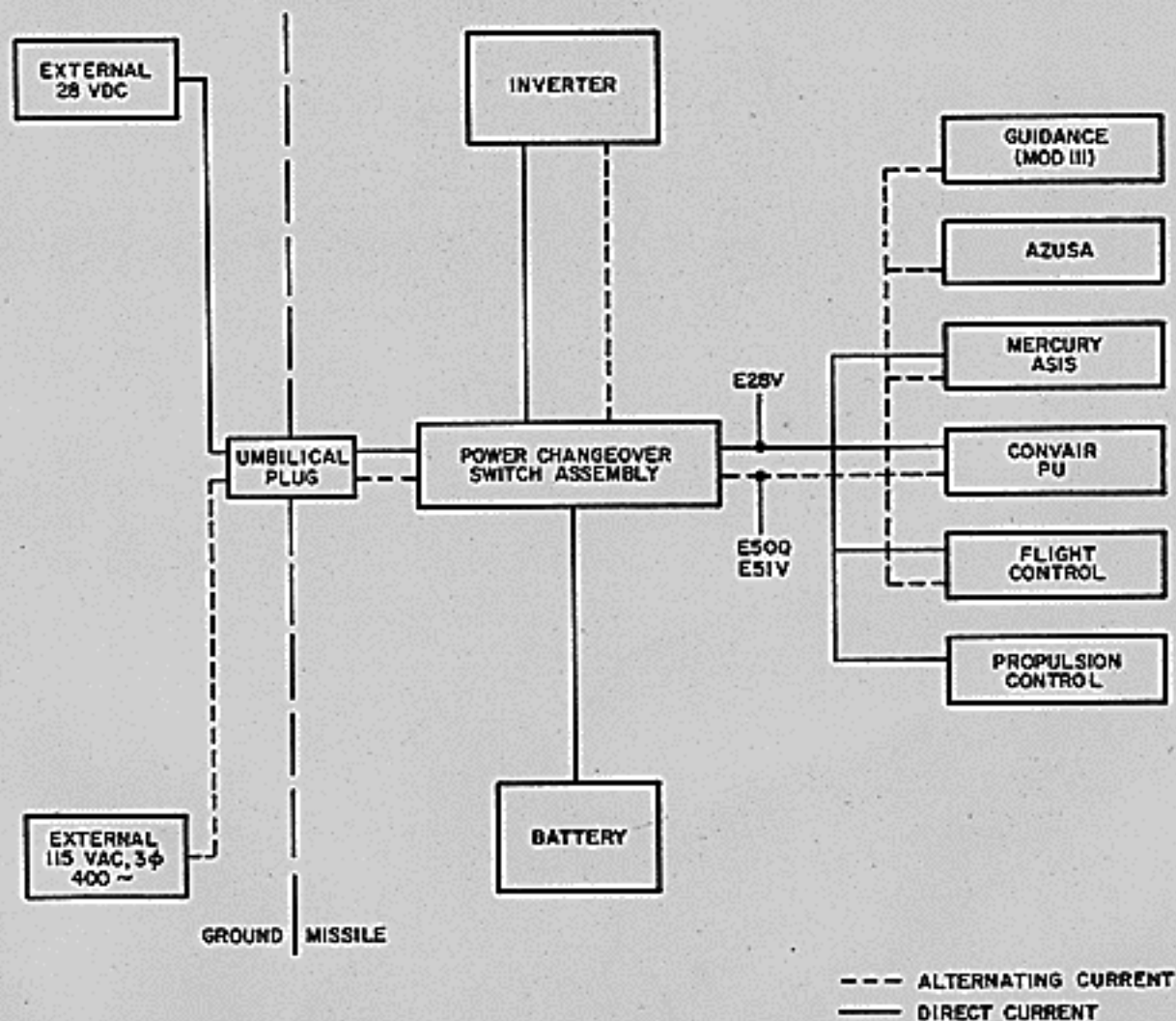


Figure 5-1. Electrical System Block Diagram

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NOTES:

TRANSISTOR SWITCH BETWEEN POINTS 1 AND 2



WHERE: E_n DENOTES THE SWITCHING CONTROL VOLTAGE FROM SW(N) IN THE PROGRAMMER

X DENOTES THE TYPE OF SWITCH, TYPE A OR B.

FOR TYPE A SWITCH (SW. IS CLOSED FOR $+E$,
SW. IS OPEN FOR $-E$.)

FOR TYPE B SWITCH	SW. IS OPEN FOR +E, SW. IS CLOSED FOR -E.
-------------------	--

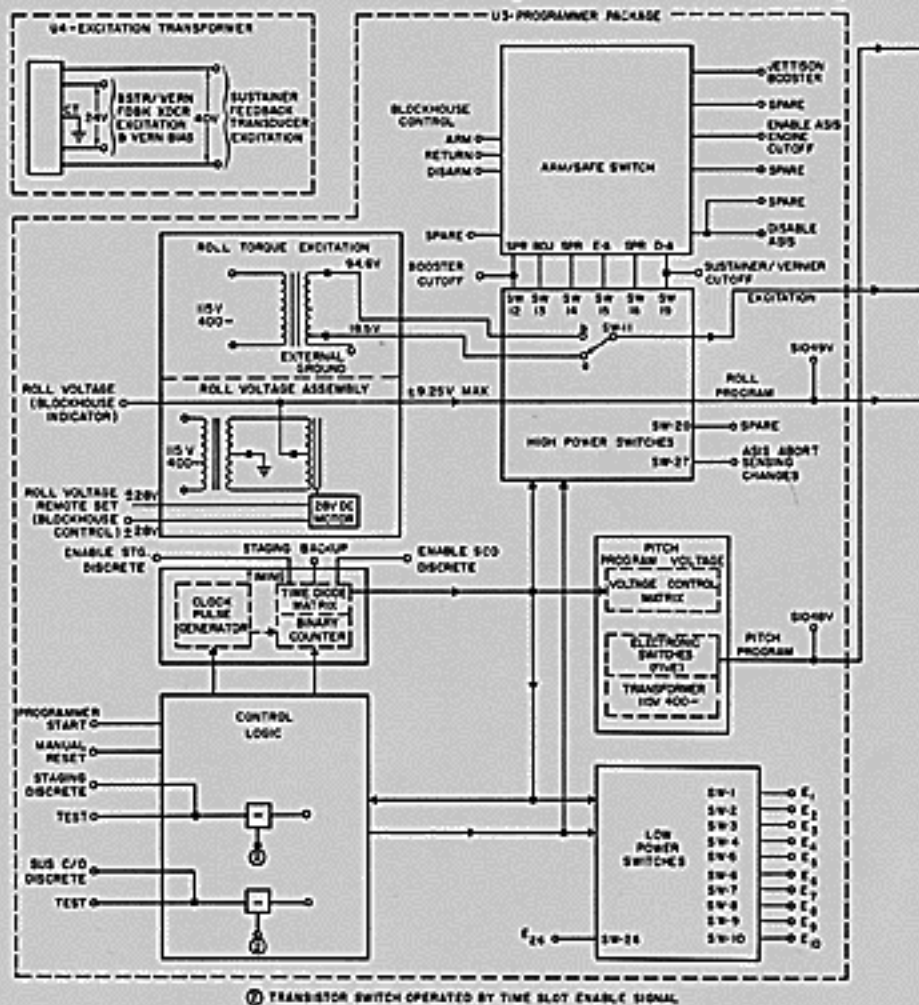


Figure 5-2a. Flight Control Circuitry

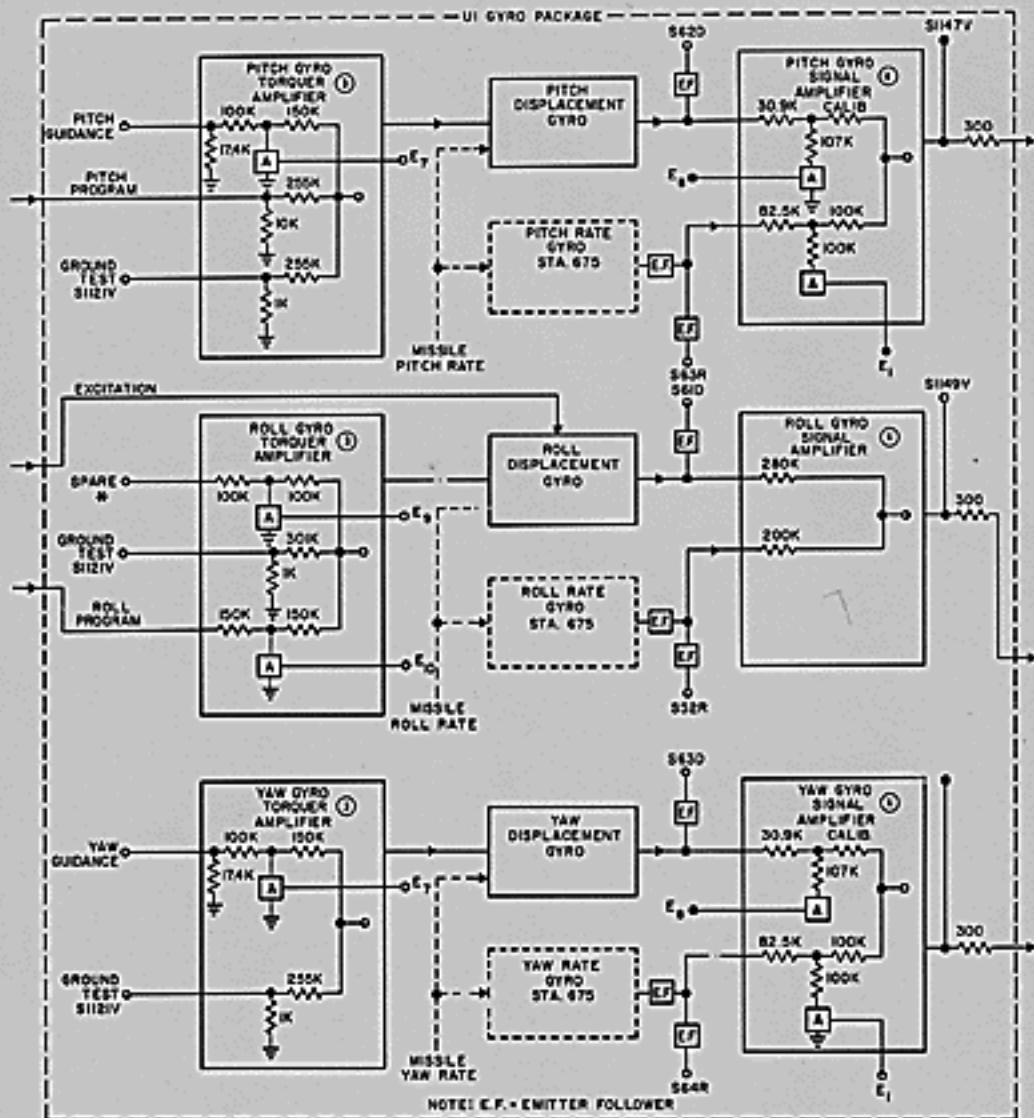


Figure 5-2b. Flight Control Circuitry

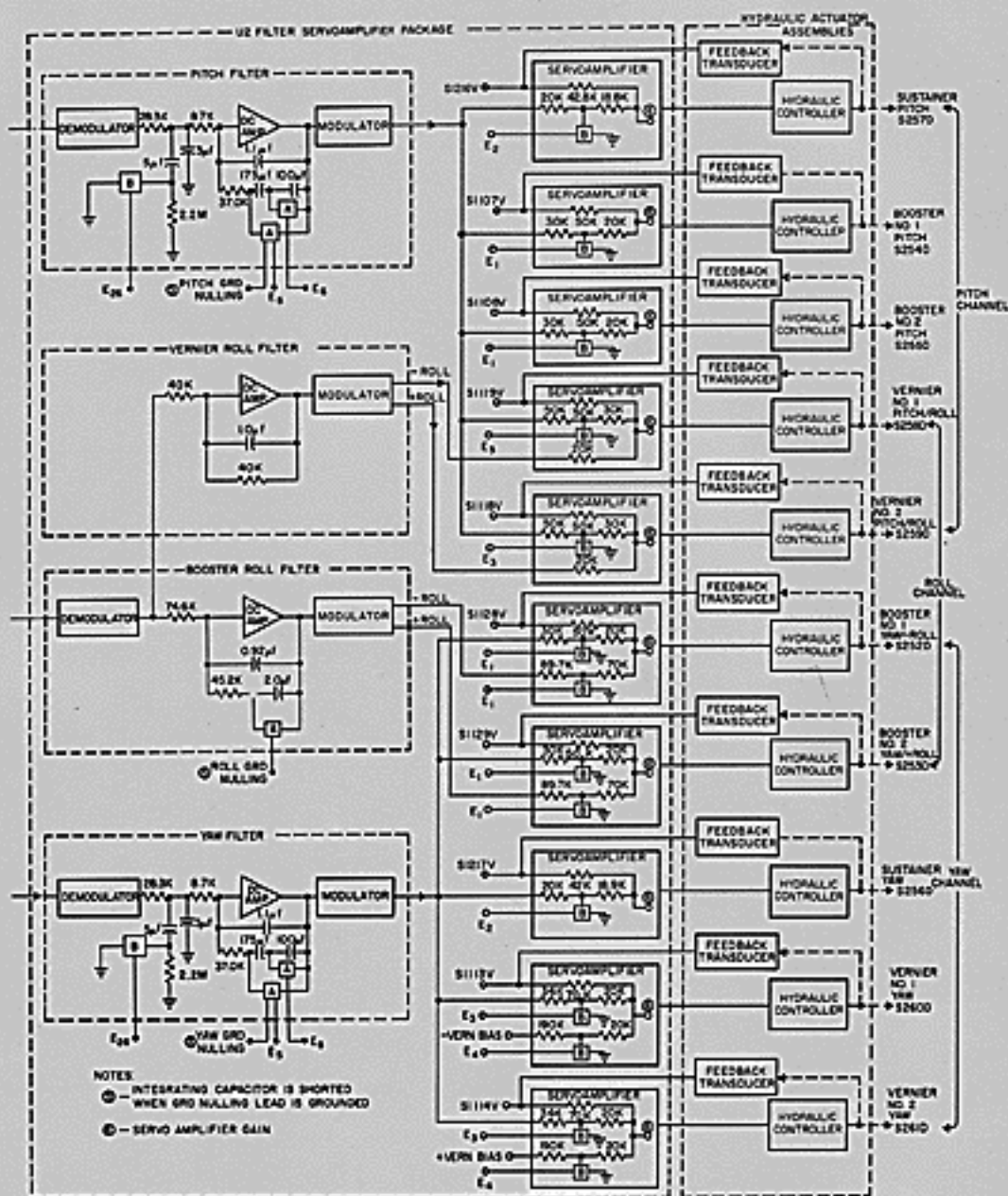


Figure 5-2c. Flight Control Circuitry

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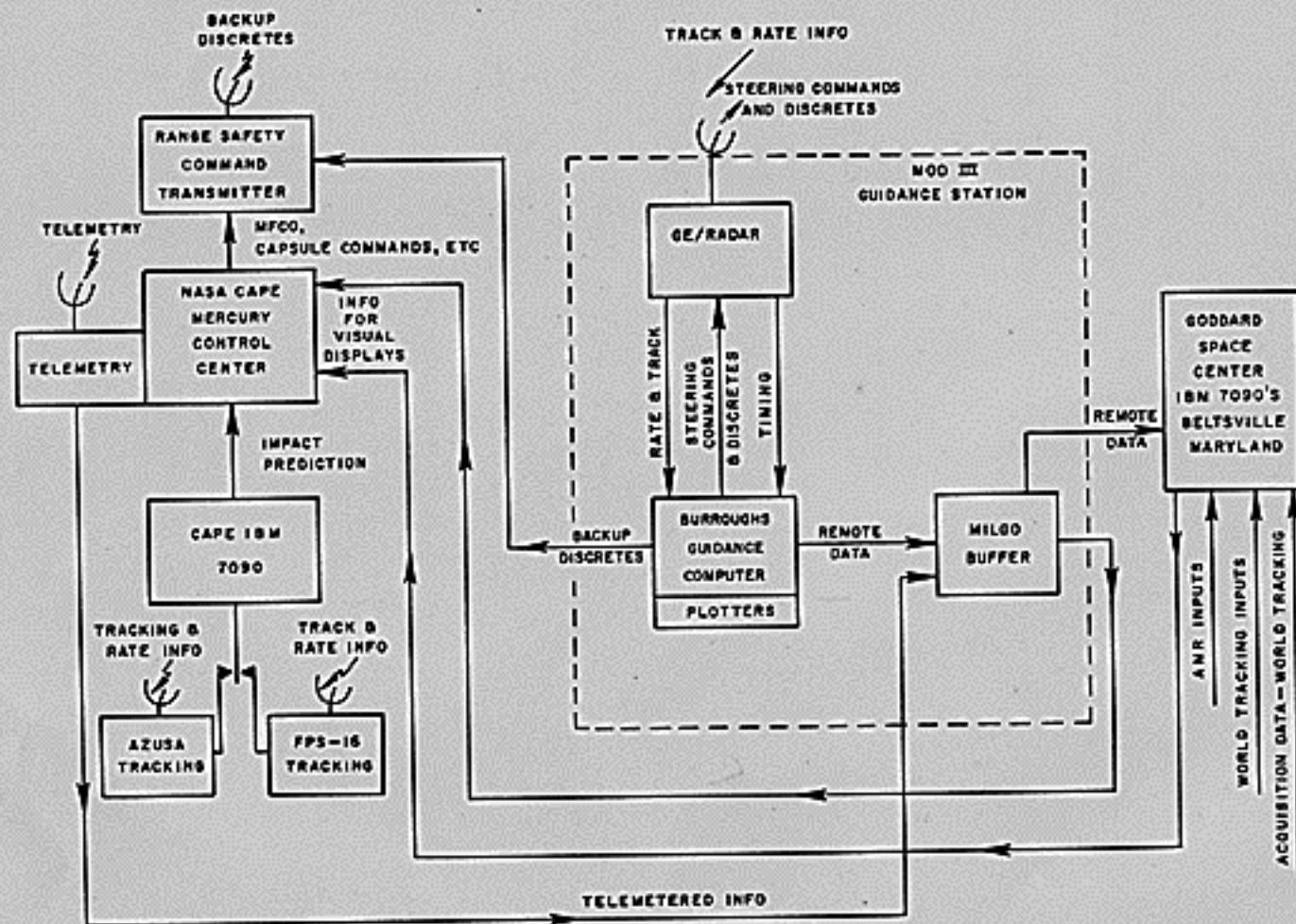


Figure 5-3. Project Mercury Guidance and Tracking Information Flow Diagram

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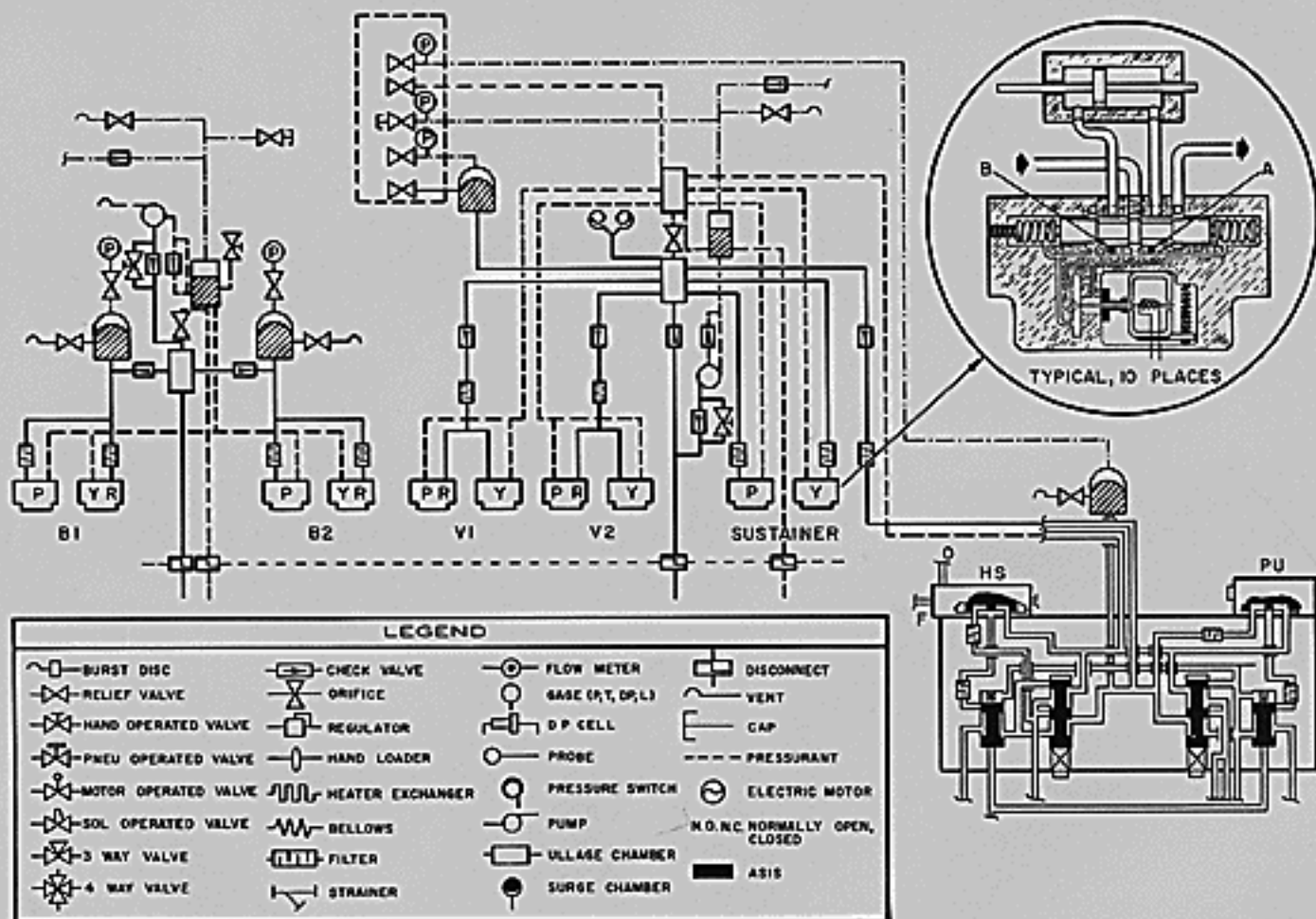


Figure 5-4. Airborne Hydraulic System

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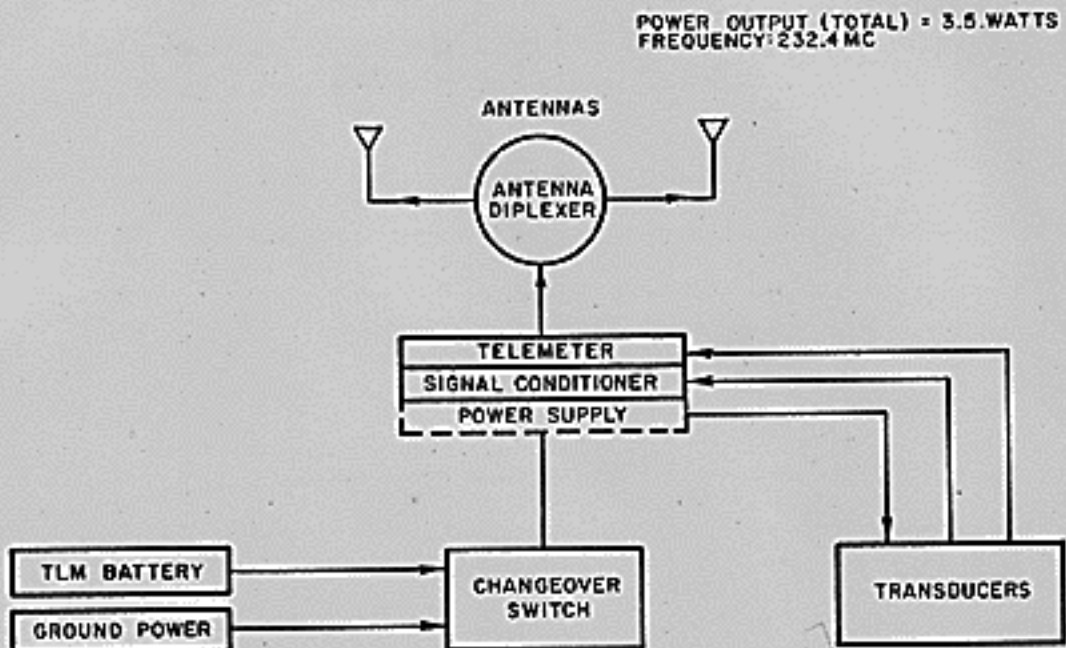
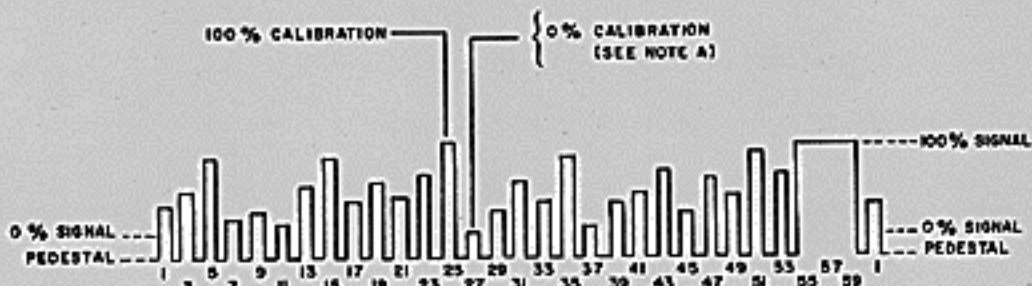


Figure 5-5. Booster Airborne Telemetry System



EFFECTIVITY: MISSILE 109D
RF-1; TELEMETER CHANNELS A, C, E.

NOTE A: ON SUBCARRIERS A, C & E, SEGMENT 27 EQUALS 0%. SEGMENT 25 EQUALS 100% CALIBRATION AND IS TIED TO SYNC PULSE (SEE NOTE B).

NOTE B: SEGMENTS 55, 56, 57, 58, 59 ARE TIED TOGETHER AND CONSTITUTE THE SYNC PULSE AS WELL AS A 100% CALIBRATION REFERENCE.

Figure 5-6. Telemetry Commutated Waveform Format

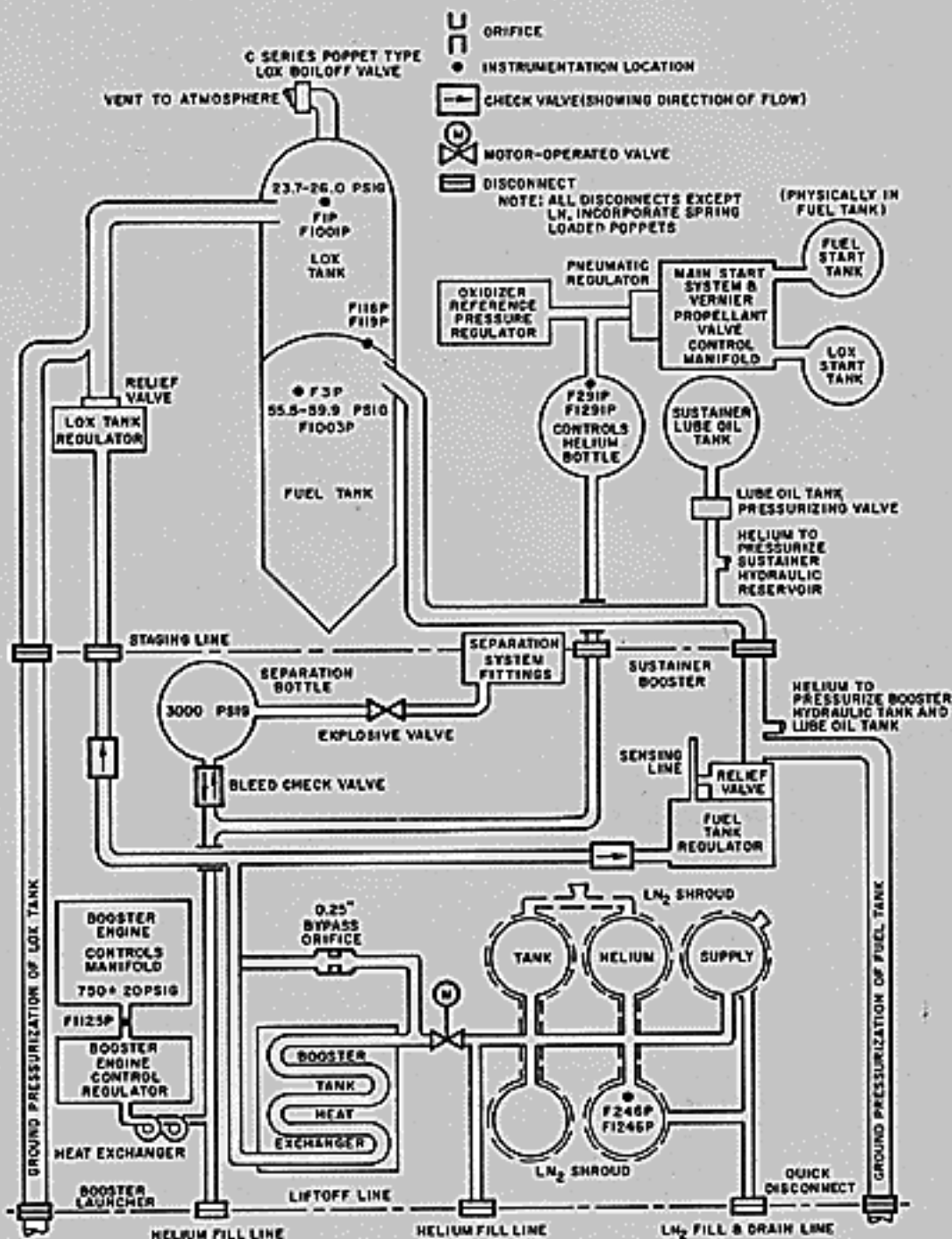


Figure 5-7. Pneumatic System

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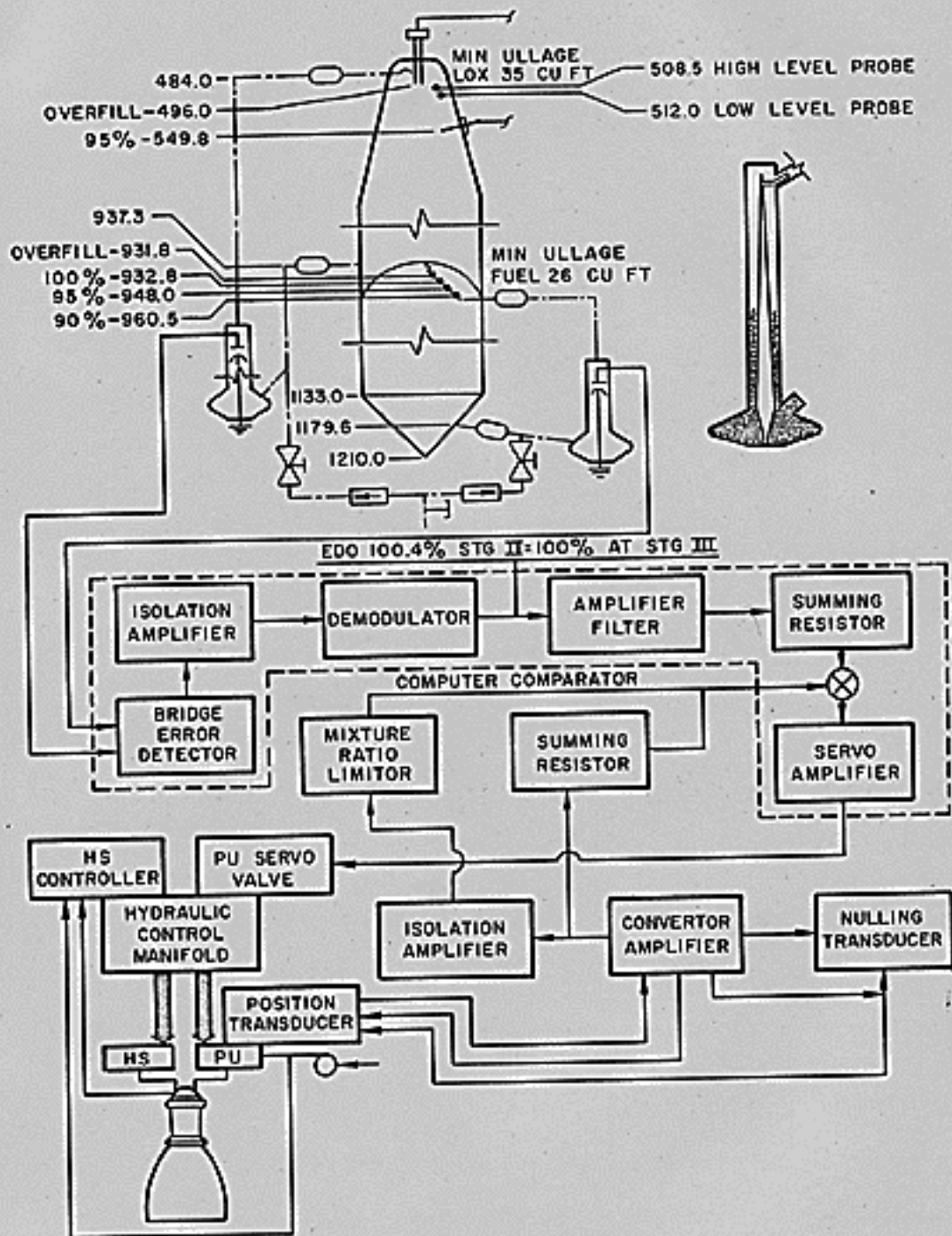


Figure 5-8. Propellant Utilization System

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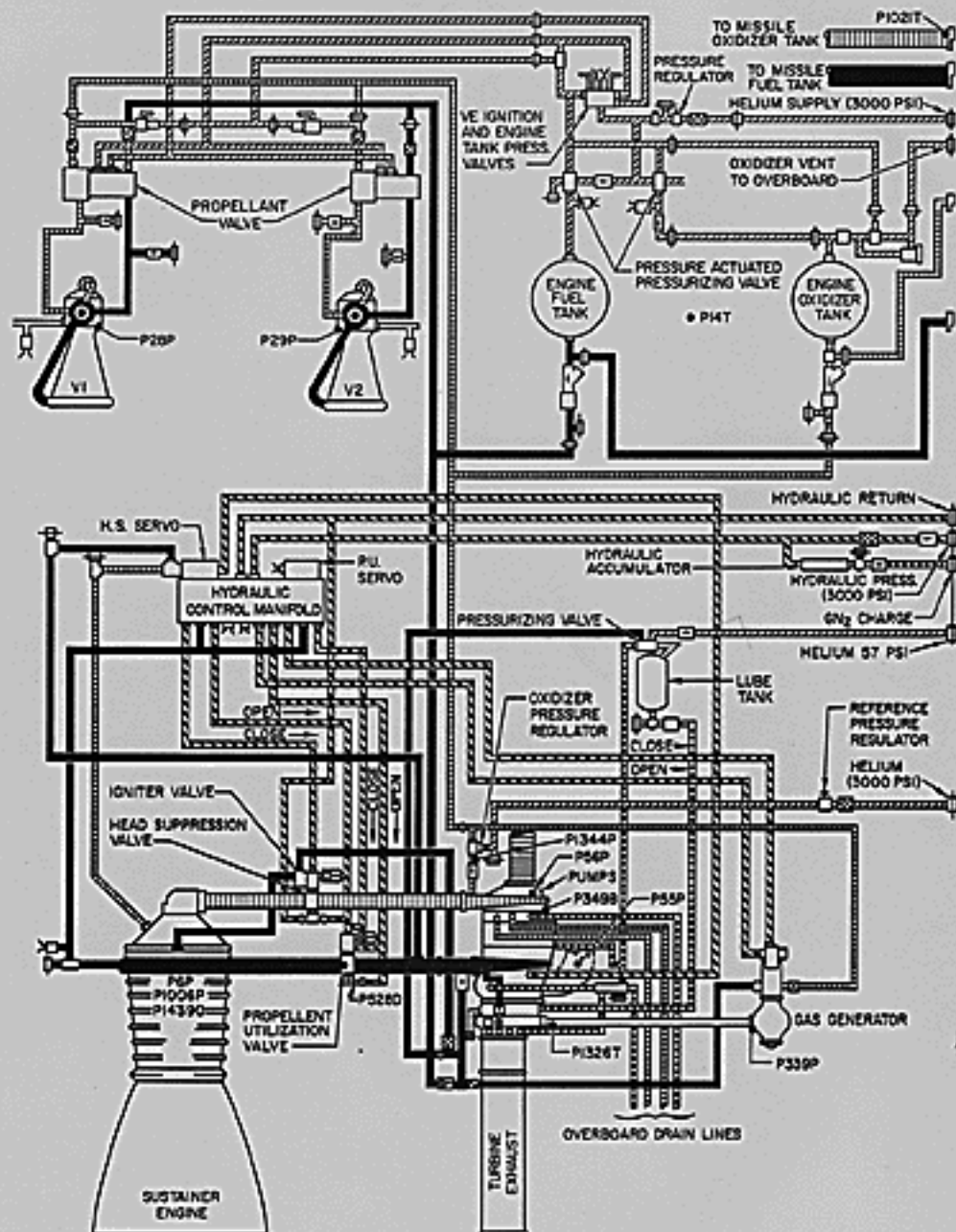


Figure 5-9a. Propulsion System.

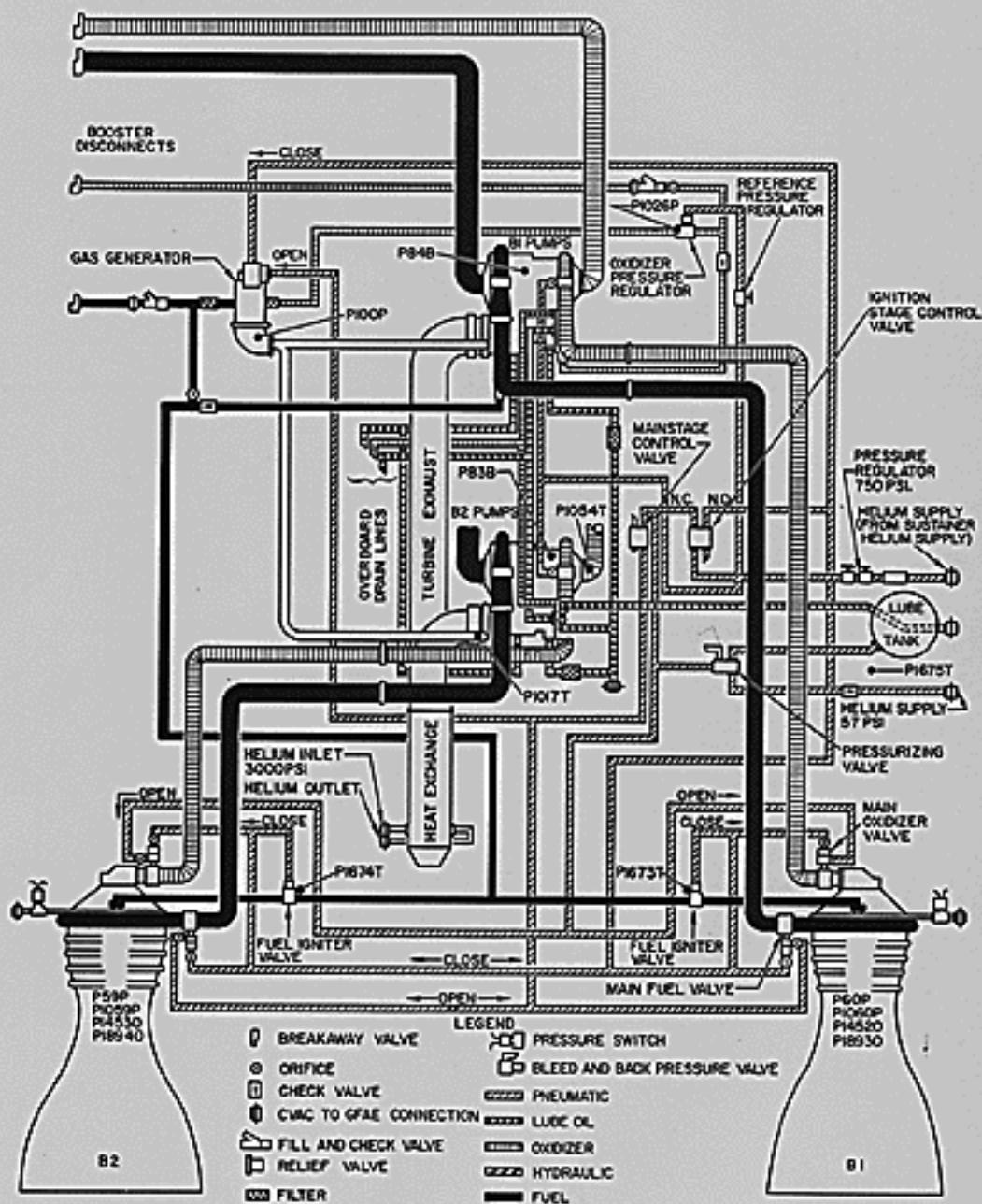


Figure 5-9b. Propulsion System

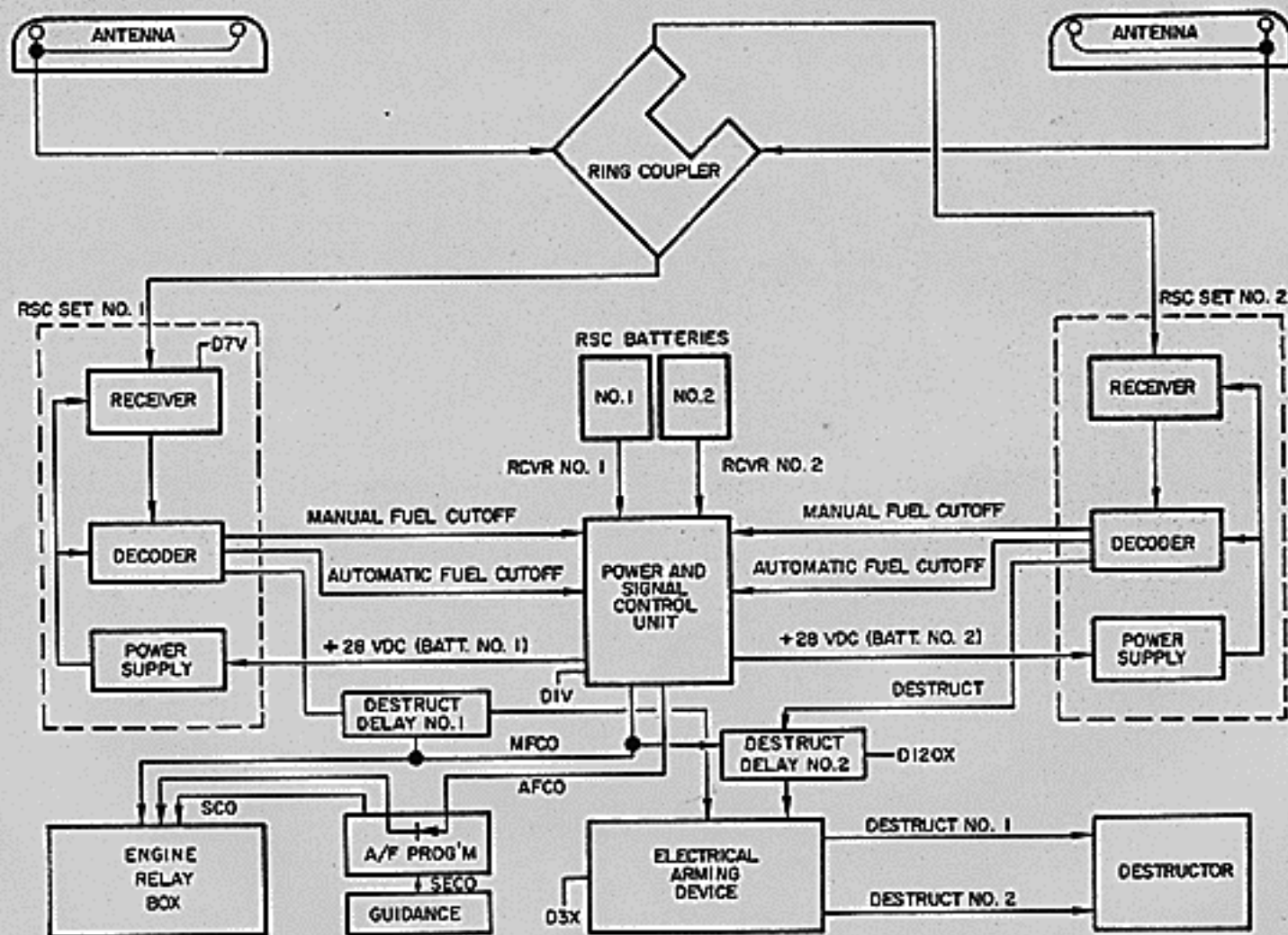
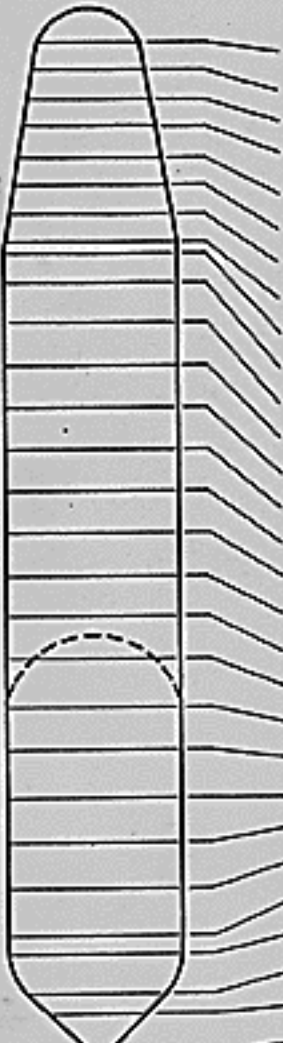


Figure 5-10. Range Safety Command System

TABLE 5-1. MERCURY/ATLAS AIRFRAME SKIN THICKNESS

	SKIN CONFIGURATION	STATION NUMBER	WET BIG JOE 10D	SKIN THICKNESS (INCHES)					
				DRY MA1 50D	DRY MA2 67D	WET MA3 100D	WET MA4 88D	DRY MA5 93D	WET MA6 109D
		502.00	.041	.011	.011	.041	.041	.041	.041
		522.00	.034	.012	.012	.034	.034	.034	.034
		542.00	.024	.012	.012	.024	.024	.024	.024
		562.00	.015	.013	.013	.015	.015	.015	.015
		582.00	.013	.014	.014	.014	.014	.014	.014
		602.00	.014	.014	.014	.014	.014	.014	.014
		622.00	.014	.015	.015	.015	.015	.015	.015
		642.00	.020	.022	.022	.022-1/2	.022	.022-1/2	.025
		649.10	.014	.014	.014	.015	.015	.014	.014
		667.00	.014	.015	.015	.015	.014	.015	.014
		696.11	.015	.016	.016	.015	.015	.016	.015
		725.22	.016	.016	.016	.016	.016	.016	.018
		754.33	.016	.017	.017	.016	.016	.017	.016
		783.44	.017	.018	.018	.017	.017	.018	.017
		812.55	.018	.019	.019	.018	.018	.019	.018
		841.66	.018	.019	.019	.018	.018	.019	.018
		870.77	.019	.020	.020	.020	.019	.020	.019
		899.88	.022	.021	.021	.020	.020	.021	.020
		928.99	.025	.023	.023	.022	.022	.023	.022
		960.00	.026	.026	.026	.026	.026	.026	.026
		992.50	.026	.026	.026	.026	.026	.026	.026
		1025.00	.026	.027	.027	.026	.026	.027	.026
		1057.50	.027	.028	.028	.027	.027	.028	.027
		1090.00	.027	.029	.029	.027	.027	.029	.027
		1122.50	.032	.034	.034	.032	.032	.034	.032
		1133.00	.023	.026	.026	.023	.023	.026	.023
		1160.54	.037	.037	.037	.037	.037	.037	.037
		1175.70	.022	.024	.024	.022	.024	.024	.022
		1198.00							

Thrust Cone

TABLE 5-2 - RADIO FREQUENCY SUMMARY

<u>MISSILE SYSTEM</u>	<u>FREQUENCY (mc)</u>
Guidance (GE Mod III)	
Ground station transmitters (interrogation)	
Track	9220.0
Rate	8462.5
Rate	8387.5
Airborne transmitters (reply)	
Track	9310.0
Rate	8425.0
Telemetry	
Atlas Telemeter No. 1	232.4
Range Safety Command - Primary	414.0
Impact Predictor (Azusa) - Interrogation	5060.0
Reply (received on the ground)	5000.0
Ground Radar	
Mod II	
Receiver (Beacon reply)	2840.0
Transmitter (Beacon interrogate)	2910.0
FPS-16	
Receiver (Beacon reply)	5480.0
Transmitter (Beacon interrogate)	5555.0

6. TEST PROCEDURES AND SPECIFICATIONS**6.1 General**

The test events, procedures and specifications presented herein are of particular importance for the achievement of the test objectives relative to the Atlas booster. Specifications (redline values) required for the launching of this vehicle will be consistent with the corresponding items listed below. Deviations or changes from values specified must be approved by the MBWG prior to launch countdown.

6.1.1 Major Mercury/Atlas Booster 109D preflight events at AMR are listed in Table 6-1. The Flight Test Directive (FTD) will detail the specific procedures applicable for each test event. All events and documentation applicable thereto will be monitored or reviewed by the appropriate Mercury Pilot Safety Program team concerned. The functions of the Pilot Safety Program teams are delineated in Appendix C.

6.2 Trajectory and Flight Sequence

The simulation for the nominal trajectory for this test is presented in Appendix B. The sequence of anticipated flight events is presented in Table 6-3.

6.3 Capsule Abort System and ASIS

The escape rocket on the escape tower provides a means of separating the capsule from the Atlas in the event an abort is required during the prestaging phase of the flight (the tower is jettisoned at approximately BECO plus 20 seconds). The tower is shimmed to separate the capsule on an azimuth heading of approximately 225° with the Mercury/Atlas vehicle on the launch complex. Abort capability/authority of Mercury/Atlas is shown in Figure 6-1 and described below.

CAPSULE EVENT SUBSEQUENT TO SECO/VECO

When the Atlas thrust decays to a point where the longitudinal acceleration is $0.20g + 1$ second, as sensed by the capsule, the capsule-adapter clamp-ring explosive bolts will be fired to release the clamp and then the posigrade rockets will fire to separate the capsule from the Atlas. After separation, the capsule Automatic Stabilization and Control System (ASCS) will call for five seconds of rate damping and then will yaw and pitch the capsule to the retroattitude. At the appropriate orbital position and with the capsule in the retroattitude, at a signal from ground command, the astronaut or the airborne capsule clock will initiate the retrofire command to enable firing of the retro-rockets and the jettisoning of the retropackage. Sixty seconds after the start of retrofire, the retropackage will be jettisoned and the ASCS will pitch the capsule down to the re-entry attitude. When the axial load factor builds up to $0.05g$, the ASCS will switch from re-entry attitude hold mode to a rate damping mode with a constant roll rate of about ten degrees per second. Upon descent to 21,000 feet, a barostat circuit initiates deployment of the drogue parachute. At 10,000 feet, the antenna fairing will be jettisoned to deploy the main parachute. At touchdown, an impact switch will disconnect the main parachute, jettison the reserve parachute, activate the recovery aids and turn off unnecessary equipment.

ABORT SEQUENCE (Before tower separation)

Upon receipt of an abort signal, three events are simultaneously activated: (1) booster and sustainer engines are cut off (possible only after $T + 30$ seconds) (2) Mayday relays are energized, and (3) the capsule adapter clamp-ring explosive bolts are fired. A microswitch then detects separation of the adapter clamp ring and initiates firing of the escape rocket. As the capsule leaves the adapter, the capsule adapter separation microswitch performs two operations: (1) starts the maximum altitude timer, and (2) initiates retropack assembly jettison. A certain time after abort initiation, the maximum altitude timer initiates the following sequence of events:

(1) the tower clamp-ring separation bolts are fired and as the clamp

ring separates, a tower clamp-ring microswitch detects separation and initiates firing of the tower jettison rocket. Tower separation is detected by a microswitch which performs two functions: (1) The landing system is armed after a 2-second time delay, and (2) the tower-separation abort interlock is energized which commands the rate-damping mode of the ASCS. Five seconds later, the ASCS accelerometer is armed to sense capsule deceleration greater than 0.05 g. The events from this point until impact follow the normal sequence.

6.3.1 Abort Prior to Capsule Umbilical Disconnect

An abort can be initiated by (1) signal from blockhouse (test conductor) through capsule umbilical and (2) signal from blockhouse (test conductor) through Atlas umbilicals J1001 and J1002.

6.3.2 Abort Prior to Liftoff*; After Capsule Umbilical Disconnect

An abort can be initiated by (1) signal from blockhouse (test conductor) through Atlas umbilicals, (2) signal from blockhouse (test conductor) and/or NASA control center through ground command RF link, and (3) signal from astronaut in capsule.

6.3.3 Abort After Liftoff*; Prior to SECO/VECO

An abort can be initiated by (1) signal from blockhouse (test conductor) and/or NASA control center through ground command RF link, (2) signal from RSO through RSC link, (3) signal from ASIS within Atlas, and (4) signal from Astronaut in Capsule.

(NOTE: Ability to shut down Atlas engines is deactivated from liftoff* until T + 30 seconds with exception of RSO action.) The threshold values of the Abort Sensing Implementation System (ASIS) will be as specified in Table 6-4.

* Two-inch motion.

6.4 Flight Control System**6.4.1 Roll Program**

The vehicle will be rolled counterclockwise during vertical ascent (liftoff + 2 seconds to liftoff + 15 seconds) from the launch azimuth of 104.977°T to the pitch plane azimuth of 72.51°T . The tolerance of the roll program will be ± 1.5 percent of the roll program (32.467°).

6.4.2 Booster Phase Pitch Program

The booster phase pitch program will be as follows:

<u>Time (sec)</u>	<u>$-\dot{\omega}_p$ (deg/sec)</u>
0-15	0.0
15-27	0.96
27-39	0.76
39-64	0.64
64-79	0.72
79-89	0.68
89-105	0.40
105-120	0.28
120-Staging	0.24

Where negative pitch rate is a nose-down command, the pitch program variation from the nominal pitch angle at staging shall not exceed ± 1.5 degrees.

6.4.3 Sustainer Phase Pitch Program

The sustainer phase pitch program will be a $2.0 \pm .05$ degree/second pitch-down between the interval of Staging + 5.0 ± 0.1 seconds and Staging + 24.0 ± 0.1 seconds.

6.4.4 Programmer Settings

Significant programmer events will be as specified in Table 6-3.

6.4.5 Flight Control System Gains

Flight Control System end-to-end gains are as indicated in Table 6-2.

The following items are to be noted pertinent to the Flight Control System.

- 6.4.5.1 Pitch and yaw rate end-to-end system gains increased 10% throughout powered flight. (Reference Missile 67D gains.)
- 6.4.5.2 Pitch and yaw end-to-end position gains decreased 12% from launch to $T_0 + 85$ seconds and from BECO + 0.1 seconds to sustainer-vernier cutoff. Pitch and yaw end-to-end position gains remain at 1.07 degrees per degree from $T_0 + 85$ seconds to BECO + 0.1 seconds. (Reference Missile 67D gains.)
- 6.4.5.3 Double vernier roll servo gains. (Reference Missile 67D gains.)
- 6.4.5.4 Incorporation of a 4 + 8 cps lag for the stabilization filter from $T_0 + 20$ seconds to $T_0 + 85$ seconds and from booster cutoff to the end of powered flight.
- 6.4.5.5 Incorporation of a 4 + 3 cps lag for the stabilization filter from launch to $T_0 + 20$ seconds and from $T_0 + 85$ seconds to BECO.

6.5 Guidance System

- 6.5.1 Nominal times of occurrence of guidance discrete commands will be shown in Table 6-3. As a backup to the SECO/VECO discrete, an ASCO (Auxiliary Sustainer Cutoff) signal will be generated in the Burroughs guidance computer within 4 milliseconds after SECO/VECO for a period of 4.0 seconds. This ASCO, through separate relay closure, will cause the range safety transmitter at Station 5 (San Salvador) to transmit the appropriate tone combination to cause cutoff of sustainer and vernier engines.

- 6.5.2 Steering commands displayed on the plot boards at the Burroughs computer will be monitored by Aerospace/STL during Mercury/Atlas missions and training simulation. As part of the Pilot Safety Abort System, the monitor will report status of the steering commands to the Flight Dynamics Officer located in the Mercury Control Center.
- 6.5.3 The octal values of manual constants representing radar bias corrections to be used in the Mod III guidance computer at Cape Canaveral will be computed at the guidance site prior to launch. The vehicle and orbit dependent constants are as follows:

<u>Manual Constant</u>	<u>Cell</u>	<u>Octal Value</u> ¹
J Six *	1125	
J Seven *	1126	
J Eight *	1127	
J Nine *	1130	
J Ten *	1131	

6.6 Hydraulic and Electric Systems

Required limits will be as specified in MBWG test document.

6.7 Instrumentation

The Atlas telemetry and landline measurements are as specified in Tables 4-1 and 4-3 respectively. The "Go/No-Go" list, as presented in Tables 4-2 and 4-4 respectively, constitutes the measurements considered mandatory for the successful accomplishment of the Atlas primary objectives. Loss of any "Go/No-Go" measurements during countdown will be cause to recommend to the NASA Operations Director that the launch be delayed until such time as a fix is made or valid data is available from alternate source.

¹To be supplied prior to flight.

6.8 Pneumatic System

6.8.1 Helium gas will be used during all pneumatic system operations at the launch site (i.e., nitrogen gas will not be used in the PCU). The system sensing lines will be purged with helium at the launch site prior to the system dynamic tests.

6.8.2 Tank pressure regulators will be set to regulate within the following limits:

Fuel Tank: 55.3 to 59.9 psig

Lox Tank: 23.7 to 26.0 psig

NOTE: The above values are regulator operating limits. Redline values will be established by the MBWG at AMR.

6.9 Propellant Loading System

Fuel will be tanked following normal "D" series procedures. Liquid oxygen will be tanked at sequence II pressure utilizing load cells for reference. Under these conditions, lox will be tanked to the Level Lo probe, the load cells' reading recorded, and an additional weight increment of 1800 pounds of lox added. Topping shall be maintained at this resultant weight until Commit Start. Subcooled lox shall be added for a minimum of six minutes. For launch Go condition, lox level at ignition at sequence III pressure shall be such that the Level Lo probe is wet and the Level Hi probe is dry. In the event Hi or Lo level probes fail, lox tanking securing weight will be 8750 ± 100 pounds above 95% probe deactivation in Sequence III pressures.

6.10 Propellant Utilization System

6.10.1 The GD-A PU computer will be nulled for a liftoff weight ratio of 2.28:1 nominal.

6.10.2 Three values of the PU valve position versus sustainer engine mixture ratio are listed below:

<u>Mixture Ratio</u>	<u>PU Valve Position</u>
1.93 (-15%)	42.9
2.27	28.5
2.61 (+15%)	23.0

6.11 Propulsion System

6.11.1 Regulator settings will be:

Booster lox reference regulator: 538 psig

Sustainer lox reference regulator: 829 psig

NOTE: The above values are the adjustment settings for the regulators and as such are specific values. Operating redline values are ± 25 psig of the set values. These values indicate maximum and minimum permissible operating limits and if exceeded could result in serious degradation of missile performance.

6.11.2 Regulator settings will be:

Engine tank pressure regulator: 600 psig

Booster pneumatic regulator: 750 psig

NOTE: The above values are the adjustment settings for the regulators and as such are specific values. Operational redline values which indicate maximum and minimum permissible operating limits and if exceeded could result in serious degradation of vehicle performance, are ± 25 psig of the set values.

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- 6.11.3 The booster engines are orificed for a sea level mixture ratio of 2.273:1 based on the standard inlet conditions. The sustainer engine is orificed for a sea level mixture ratio of 2.27:1 based on standard inlet conditions and the nominal PU valve setting.
- 6.11.4 3.0 seconds of holddown time will be programmed.
- 6.11.5 The RCC networks remain active from the opening of the main fuel valve until the holddown timer times out.
- 6.11.6 Booster RCC setting: 30 g with 40 millisecond count.
Sustainer RCC setting: 60 g with 20 millisecond count.
- 6.11.7 The inert wet lead start technique will be used for ignition of the booster engines.

6.12 Range Safety

- 6.12.1 Range Safety requirements for the launching and flight of this vehicle will be established by, and be the responsibility of the AMR Range Safety Officer. Guidance constants and engine parameters will be furnished to GD-A by Aerospace for preparation of a Range Safety Report for submission to the 6555th Test Wing. The Impact Probability Study will be generated by Aerospace based upon the RSR.
- 6.12.2 Transmission of manual fuel cutoff is not required; however, the capability does exist.

6.13 Weather at Launch

The following data will be supplied by NASA relative to launch area winds: wind velocity in knots and azimuth in degrees from North, in altitude increments of 2,000 feet from sea level to 60,000 feet for the following times:

- a. X-2 day sounding forecast for T-0 (launch).
- b. X-1 day sounding forecast for T-0.

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- c. T-12 hour forecast for T-0.
- d. T-5-1/2 hour forecast for T-0.
- e. T-2 hour forecast for T-0.
- f. T-0 wind sounding.

The T-12 hour through T-2 hour forecasts will be provided at these respective times. Additional soundings to 60,000 feet between T-2 hours and launch may be required in the event the forecast at T-2 hours indicates a serious trend of increasing wind velocity, or in the event launch is delayed such that there would be a time span of more than five and one-half hours between the T-2 hour forecast sounding and launch.

The forecast wind values will be used in a computer program to determine the expected alpha-q along the flight path during flight. These computed values of alpha-q will be compared to the allowable values presented in Figure 6-2 and thus will serve as a basis for a Go/No-Go recommendation for the booster.

The visibility at launch should be such as to allow continuous photographic coverage from liftoff through staging.

6.14 X-3 Day Mission Review Briefing

As part of the X-3 day NASA mission review briefing, a presentation on the Atlas booster will be given by SSD/Aerospace. The presentation will include:

- MA-5 summary.
- MA-6 booster mission.
- MA-6 booster configuration.
- Alpha-q launch criteria.
- MA-6 booster history/major difficulties, fixes, pilot safety team activities, etc.
- X-3 day booster status.

6.15 Data Analysis Requirements**6.15.1 Quick Look Data Evaluation (Atlas Booster)**

A preliminary evaluation analysis will be made at AMR which will be conducted on the basis of real time and early playback data, as well as other data which may be necessary to determine the success of the flight. This evaluation should point out any major discrepancies or malfunctions which occurred during the flight. A preliminary flight test report will be prepared by the MBWG at AMR subsequent to the flight test. The format for this report will be in accordance with Reference (g).

6.15.2 Detailed Evaluation (NASA Mission)

The analysis of the NASA mission will be the responsibility of NASA utilizing all data obtained from all phases of the flight. A detailed analysis of the Atlas test data will be made by the cognizant contractors and by SSD/Aerospace.

NOTE: NASA raw data and associated transducer calibrations will be furnished to SSD/Aerospace to assist in the test evaluation.

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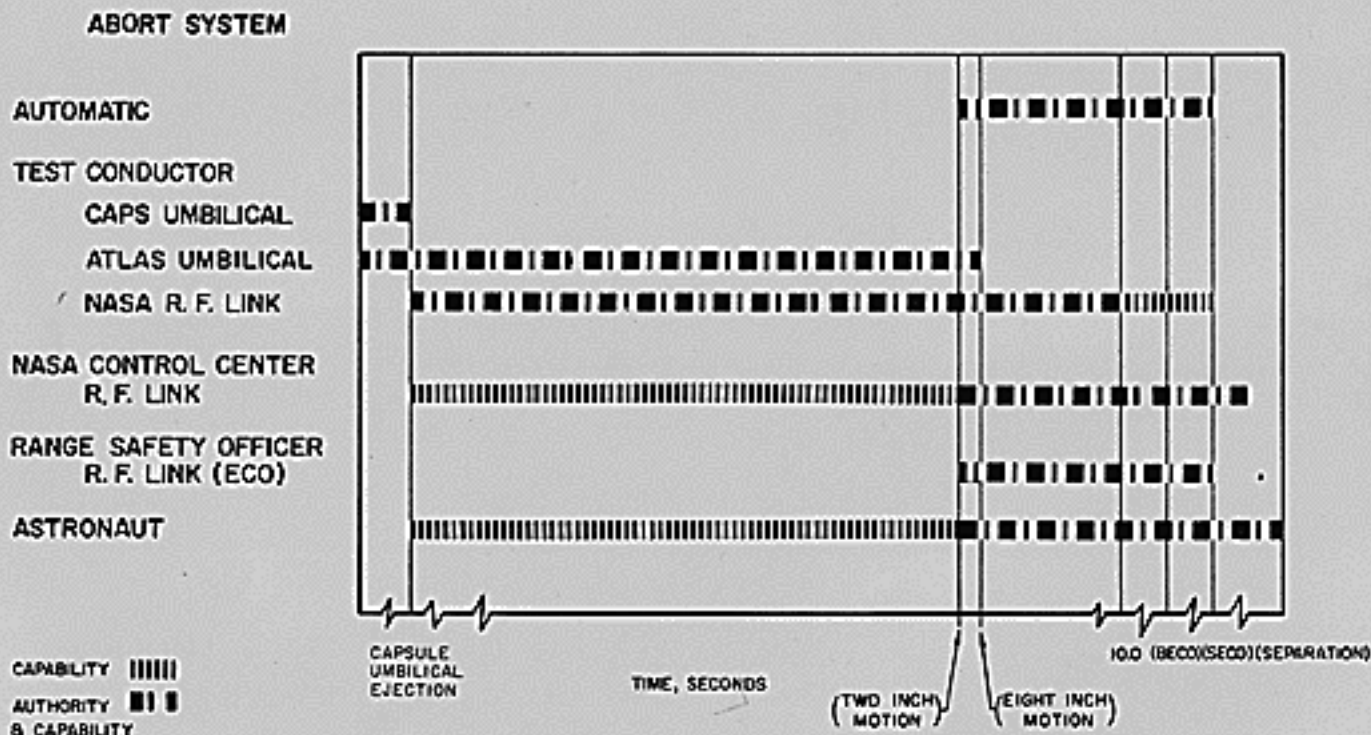


Figure 6- 1. Abort Capability/Authority of Mercury/Atlas

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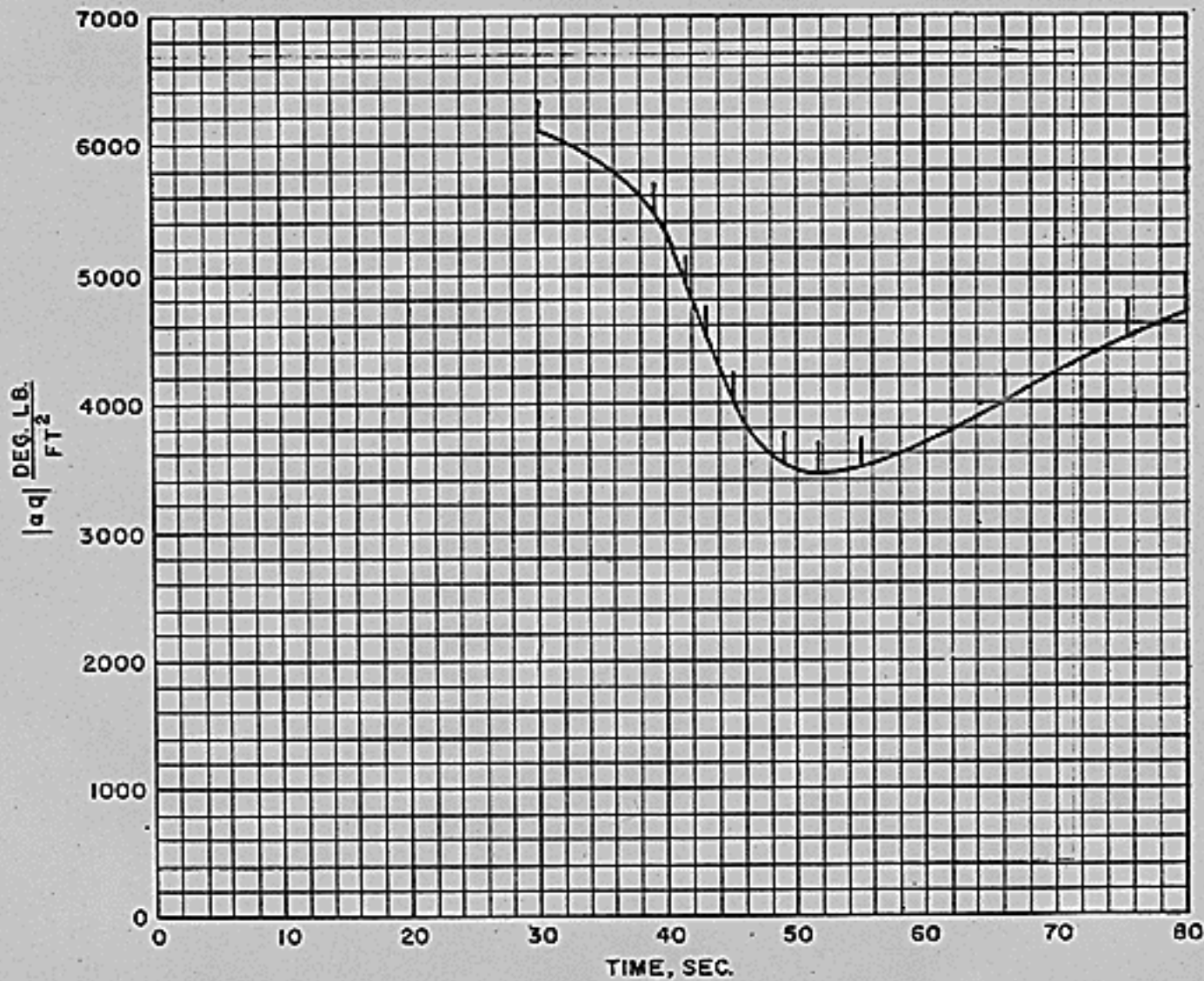


Figure 6-2 Allowable Alpha Q Due to Wind Profile for Atlas/Mercury Vehicle 109D

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TABLE 6-1

MAJOR MERCURY/ATLAS BOOSTER 109D PREFLIGHT EVENTS AT AMR

<u>Test Events</u>	<u>Purpose</u>	<u>Summary</u>
Missile Receiving and Inspection	Missile Integrity	Pods, tank section, thrust section inspected for damage, rust and/or corrosion. Missile completeness and system components utilized checked against pilot safety program requirements and applicable documents.
Systems Tests (Hangar Area)	Systems performance	Minimum abbreviated system checks only. Major system checks formerly completed here are now completed with vehicle erect at complex.
Compatibility Test	Verifies the mechanical compatibility of the capsule - capsule adapter and Mercury/Atlas booster.	Verification of capsule - capsule adapter mechanical fit, umbilical lengths, clearance, capsule umbilical separation operation, and capsule landline circuits.
Systems Tests (Complex Area)	Determination of operational readiness.	Azusa, Telemetry, RSC, Electrical, Guidance and Flight Control are functionally checked for operational readiness. Autopilot - Guidance Integrated System Tests, A/P Frequency Response, PU and ASIS are checked per applicable FTD procedure.
Flight Acceptance Composite Test (FACT)	Integrated check of all Mercury/Atlas systems and capsule systems prior to flight.	An integrated check of missile systems, launch complex, GMCF No. 1 and applicable range stations is accomplished. Proper operation of 1) all missile systems on internal missile power, 2) circuits involving pyrotechnics, 3) engine firing circuits, and 4) umbilical ejection is evaluated. All missile and capsule r-f systems are radiating simultaneously for evaluation of interaction effects.

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TABLE 6-2. FLIGHT CONTROL END-TO-END GAINS

	Booster No.	0 - 20 sec	Booster P and Y 20 - 47 sec	85 - BGO	Booster Roll	Sustainer P and Y	Vernier P	Vernier Y	Vernier R
*Position deg/deg	**109D	1.35 ± 10%	1.35 ± 10%	1.07 ± 10%	.648 ± 10%	1.11 ± 10%	13 ± 12%	20.0 ± 12%	15 ± 12%
**Rate deg/deg/sec	109D	.475 ± 10%	.475 ± 10%	.475 ± 10%	.027 ± 10%	.56 ± 10%	6.9 ± 12%	10.0 ± 12%	6.0 ± 12%
***Integral deg/deg/sec	109D	.58 ± 10%	.58 ± 10%	.460 ± 10%	.137 ± 10%	.173 ± 10%	0	0	0

* Overall gains. Engine deflection vs. Gyro input. Integrator shorted.

** 93D and 109D end to end gains are identical.

***Overall gains. Engine deflection vs. Gyro input.

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TABLE 6-3 - FLIGHT EVENTS SEQUENCE

Nominal Time In Seconds	Subroutine	Function and/or Action	Initiated By
T-7.15	--	The autopilot displacement gyros are uncaged.	Engine start
0.0	--	Atlas flight control system (AFCS) Programmer is started when the missile has risen 2 inches off the start position; ASIS is enabled.	--
+0.175	--	All umbilicals except gyro null umbilicals are ejected when the missile has risen 8 inches. Holddown arms are also retracted. Backup enabling of ASIS is accomplished.	--
+0.7	--	Gyro null umbilical is ejected when the missile has risen 42 inches; the autopilot gyro signals are ungrounded at this time, the booster engines are free to gimbal in pitch, yaw and roll; and the vernier engines are free to gimbal in roll only.	--
+2.0	--	A roll program is initiated which rolls the missile from the launch stand azimuth to the prescribed pitch plane azimuth.	AFCS Programmer
+15.0	--	The roll program is terminated. The booster phase pitch program is initiated by gimbaling the booster engines.	AFCS Programmer
+20.0	--	Pitch and yaw filter change.	AFCS Programmer
+30.0	--	The automatic engine cutoff feature of the ASIS is enabled.	AFCS Programmer
+85.0	--	Change filter combination and position gain in pitch and yaw.	AFCS Programmer
+120.0	--	Staging subroutine command is enabled.	AFCS Programmer

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Nominal Time In Seconds	Subroutine	Function and/or Action	Initiated By
131.34	Staging	Staging subroutine is initiated by BECO Command.	Guidance
+136.0	--	Backup staging command.	AFCS Programmer
Mark 1	Staging +0.1 second	a. Cutoff booster engine. b. Stop programmer pitch program. c. Null booster engines in pitch, yaw and roll. d. Activate sustainer engine in pitch and yaw. e. Activate vernier engines in pitch and yaw. f. Change autopilot gyro gains and integrator limits in pitch and yaw. g. Change filter combination in pitch and yaw. h. Null integrator in pitch and yaw. i. ASIS pitch and yaw rate gyro trigger levels are changed to double rate.	AFCS Programmer
Mark 2	Staging +3.0 seconds	Sustainer engine is nulled and booster section jettisoning commences. ("Jettison One")	AFCS Programmer
	Staging +3.7 seconds	Sufficient clearance between sustainer and jettisoning booster section attained; sustainer engine is released to gimbal in pitch and yaw.	AFCS Programmer
	Staging +5.0 seconds	Enable guidance pitch and yaw steering	AFCS Programmer
	Staging +5.0 seconds	Sustainer phase pitch program is started.	AFCS Programmer

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<u>Nominal Time In Seconds</u>	<u>Subroutine</u>	<u>Function and/or Action</u>	<u>Initiated By</u>
	Staging +6.7	Vernier engines are nulled in pitch and yaw but continue to gimbal in roll. (Yaw null is 50° away from vehicle centerline.)	AFCS Programmer
	Staging +10.0	Integrators changed to active.	AFCS Programmer
Mark 3	Staging +20	Jettison capsule escape tower ("Jettison Two")	Capsule Circuitry
	Staging +24	Sustainer phase pitch program is stopped.	AFCS Programmer
Staging +25.0	--	Initiate Guidance steering.	Guidance
Staging +30.0	--	ASIS pitch and yaw rate gyro trigger levels are changed to normal.	AFCS Programmer
Staging +80.0	--	Sustainer engine cutoff (SECO) is enabled.	AFCS Programmer
Mark 4 303.8	SECO/VECO	ASIS is disabled. SECO subroutine is initiated; sustainer and vernier engines are cut off. ASCO signal is generated.	Guidance

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TABLE 6-4. ASIS THRESHOLD VALUES

Parameter	Pre-Staging Values ¹			Staging Values ²			Post-Staging Values ³		
	Nom.	+	-	Nom.	+	-	Nom.	+	-
Pitch Rates (Primary Set) ⁴ deg/sec	3.00	0.3	0.3	6.00	1.0	1.0	3.00	0.3	0.3
(Backup Set) deg/sec	4.75	0.47	0.47	9.50	1.6	1.6	4.75	0.47	0.47
Yaw Rates (Primary Set) ⁴ deg/sec	3.00	0.3	0.47	6.00	1.0	1.0	3.00	0.3	0.3
(Backup Set) deg/sec	4.75	0.3	0.47	9.50	1.6	1.6	4.75	0.47	0.47
Roll Rates (Primary Set) ⁴ deg/sec	6.40	0.64	0.64	6.40	0.64	0.64	6.40	0.64	0.64
(Backup Set) deg/sec	9.40	0.94	0.94	9.40	0.94	0.94	9.40	0.94	0.94
Lox Tank Pressures, psid	21.5	1.00	1.00	11.0	1.00	1.00	11.0	1.00	1.00
Lox/Fuel Tanks Diff. Press ⁵ psid	2.5	1.00	1.00	2.5	1.00	1.00	2.5	1.00	1.00
Fuel Manifold Press, Booster psia	470	25	25	None	-	-	None	-	-
Fuel Manifold Press, Sustainer psia	560	25	25	560	25	25	560	25	25
Hydraulic Press, Sustainer psia	2,000	60	60	2,000	60	60	2,000	60	60
Phase A, 400 cps, Voltage ⁶ Volts	80	0	20	80	0	20	80	0	20

1. Pre-Staging Values are the parameter threshold values and tolerances from 2-inch motion to Booster Engine Cutoff.
2. Staging Values are the parameter threshold values and tolerances for 30.0 ± 0.5 seconds following Booster Engine Cutoff.
3. Post-Staging Values are the parameter threshold values and tolerances from Booster Engine Cutoff plus 30.0 ± 0.5 seconds to Sustainer/Vernier Engine Cutoff.
4. The gyro rate signals are monitored through low pass filters with the following corner frequencies:
 - a. Primary set, 0.71 ± 0.16 cps
 - b. Backup set, 2.0 ± 0.7 cps

$$\text{where } \frac{E_{\text{out}}}{E_{\text{in}}} = \frac{1}{\sqrt{1 + \omega^2 \tau^2}}$$

5. The Lox/Fuel Tanks Differential Pressure is the pressure existent across the intermediate bulkhead. The lox side is monitored through a pneumatic filter with a minimum attenuation of 4:1 at 5 cps with an 8 psi peak to peak input pressure. Maximum delay time thru pneumatic filter is 125 milliseconds at 1 cps. Helium purge rate is 14 ± 1.0 SCFH.

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7. REFERENCES

- (a) ARDC Report, "Space System Development Plan, Research for and Support of Project Mercury," 12 June 1959.
- (b) AFMTC Document No. MT60-24978 "Operations Requirements No. 1905 MA-6 Mercury Operations."
- (c) NASA Document, "Project Mercury Mission Directive for Mercury-Atlas No. 6."
- (d) NASA Document, "Project Mercury General Systems Information Document," NASA Working Paper No. 118.
- (e) Aerospace Report AS-60-0000-00336, "General Flight Plan-Atlas Boosters for Project Mercury," dated September 1960.
- (f) STL Report TR-59-0000-00673, "Atlas Man-in-Space Program Requirements at AFMTC," revised July 1959.
- (g) AFMTC Document No. MT-60-24937, "Mercury Program Requirements, No. 1900."
- (h) AFMTC Document No. MT-60-7371, "Atlas Program Requirements, No. 1000."
- (i) AFBMD/Aerospace Publication, WDZJM 60-10-31 "Pilot Safety Program of the Atlas Booster for NASA Project Mercury."
- (j) AFBMD/STL Report STL/TR-60-0000-69106, "Atlas Booster Factory Rollout Inspection General Operating Procedures and Organization," dated 6 June 1960.
- (k) AFBMD/STL Report STL/TR-60-0000-69079 "Atlas Booster Flight Safety Review General Operating Procedures and Organization," dated 6 June 1960.

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APPENDIX A
DEFINITIONS

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**APPENDIX A
DEFINITIONS**

The following definitions are intended to assist the AMR operations personnel in the establishment of action to be taken regarding the loss of Atlas telemetry data or systems during the checkout and launching procedures. The course of action required when data is lost or systems indicate improper performance will be decided by the NASA Operations Director based upon the recommendations of the AFSSD/AEROSPACE launch directors and the condition of operational readiness of all other elements and/or operations required for the performance of the flight mission.

A. Definitions of Test Objective Orders

First Order Objectives ("1") - The essential or primary mandatory reasons for the flight of the test vehicle. The inability to accomplish first order objectives will seriously delay the timely advancement of the program.

Second Order Objectives ("2") - Those required to determine the over-all performance of the test vehicle or the operation of specified systems. The inability to accomplish second order objectives may delay, but not necessarily compromise, the timely advancement of the program.

Third Order Objectives ("3") - Those desired to furnish supplementary data for the over-all vehicle evaluation, for support of future flights, or for special systems investigations. The inability to accomplish third order objectives will not significantly delay the timely advancement of the program but may limit the level of comprehension of the performance of the over-all vehicle.

B. Definitions of Objective Terminology

The terms defined below establish a standard datum for uniform interpretation of the test objectives.

Evaluate - Denotes the measuring of performance of any unit or system as well as the performance and/or interaction of its sections or subsystems that are under investigation. The accomplishment of objectives of this type requires quantitative data on the performance of both the unit or system and its sections or subsystems. Instrumentation for this category generally includes measuring the basic inputs and outputs of the unit or system as well as the basic inputs and outputs of its sections or subsystems. The performance levels of the sections or subsystems will then be analyzed for their contribution toward performance of the unit or system. This category will provide the most detailed information of any of these categories.

Determine - Denotes the measuring of performance of any unit or system. This category implies the quantitative investigation of over-all operation which includes, generally, instrumentation for measuring basic inputs and outputs of the unit or system. The information obtained should indicate to what extent the system is operating as designed. The instrumentation should allow performance deficiencies to be isolated to either the system or to the system inputs.

Demonstrate - Denotes the occurrence of an action or an event during the test. The accomplishment of this type objective requires a qualitative answer. The answer will be derived through the relation of this action or event to some other known information or occurrence. This category of objective implies a minimum of airborne instrumentation and/or that the information be obtained external to the vehicle.

C. Definition

Hold-down-time - The time delay programmed between the "Main Engines Complete" and "Pre-release Cut-off Disarm" Signals.

Mandatory Data (M) - Data which are essential to the fulfillment of the test objective which it supports. Loss of mandatory data will jeopardize the accomplishment of the referenced objective.

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Required Data (R) - Data which increases the level of comprehension of the fulfillment of the test objective which it supports and/or is necessary for detailed analysis of system performance. The loss of small quantities of required data on any system will not jeopardize the attainment of the referenced objective. The quantity of data which can be lost is dependent upon the total amount of data available for determining the performance of the system.

Landline Instrumentation Symbol Identification - See Table A-1.

Azusa MK II Tracking Data Abbreviations - See Table A-2.

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TABLE A-1 - LANDLINE INSTRUMENTATION SYMBOL IDENTIFICATION

SYMBOL	SYSTEM	TYPE MEASUREMENTS	TYPE INSTRUMENTATION RECORDER
A	Airframe	Acceleration	AM Tape
B		Rotation Rate	
C		Current	
D	Range Safety Command	Deflection	Sanborn Recorder
E	Electrical	Power	Eput meter, counter
F	Pressurization	Force	FM tape
G	Guidance (Radio)		Esterline-Angus-Type
H	Hydraulic	Position	AW Graphic Recorder
I	Guidance (Inertial)	Intensity	
J			
L	Launcher	Velocity	Panel Light
M	Miscellaneous	Mass	Meter
N	Facilities and Site	Camera Coverage	
O		Vibration	Oscillograph (CEC)
P	Propulsion	Pressure	Printer
Q		Frequency	
R		Rate	EA Sequence Recorder
S	Flight Control	Strain	Strip Chart (Brown Speedomax)
T	Telemetry	Temperature	
U	Propellant Utilization		
V		Voltage	Visual panel gauge
W		Time	
X	External	Discrete Position	
Y	Payload	Acoustical	
Z	Azusa Transponder	Azimuth	

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TABLE A-2 - AZUSA MK II TRACKING DATA ABBREVIATIONS

t	=	time
l	=	cosine of angle described by line of sight from center of baseline to the vehicle and the x baseline of the Azusa system.
m	=	cosine of angle described by line of sight from center of baseline to the vehicle and the y baseline of the Azusa system.
r_m	=	slant range from center of Azusa baseline.
l_c	=	incremental cosine from Azusa 500 meter x baseline.
m_c	=	incremental cosine from Azusa 500 meter y baseline.
r_c	=	the incremental slant range.

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APPENDIX B
TRAJECTORY SIMULATION

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APPENDIX B
TRAJECTORY SIMULATION

- B. The launch trajectory for the MA-6 mission, the first manned three-orbit flight in the Mercury program, is similar to the launch trajectory for the MA-5 mission. The vehicle will utilize the modified square autopilot, the MA-6 first stage pitch program, and the second stage open loop pitch turn prior to start of guidance. This vehicle will be launched along the same pitch plane azimuth as MA-4 and MA-5.

The closed-loop guidance during the sustainer phase, is mechanized exactly as on MA-4 and MA-5 as it is intended for future missions. At separation, the Mercury capsule is at the perigee of its assigned orbit. Retrograde rocket firing during the third orbit, initiates the re-entry and recovery sequences terminating the mission northeast of the Dominican Republic.

Significant trajectory results are listed below:

1. Launch:

Stand	14
Geodetic Latitude	28.4913°N
Longitude	80.5474°W
Missile Antennas above MSL	60 ft
Pad Azimuth	104.977°T
Pitch Plane Azimuth	72.51°T

2. Weights and Loadings

Liftoff	260,131 lbs
Available oxidizer	168,714 lbs at 70.33 lbs/ft ³
Available fuel	73,502 lbs at 49.93 lbs/ft ³
Ground run (Ignition to liftoff)	5.00 seconds

Jettisoned booster	7100 lb
Jettisoned tower	1064 lb
Capsule at separation	2951 lb (includes 40 lb growth allowance)

3. Propulsion - MA-5

Booster sea level I_{SP}	252 sec
Booster mixture ratio	2.273
Sustainer sea level I_{SP}	217 sec
Liftoff thrust	366,172 lb
Liftoff flow rate	1497 lb/sec
Liftoff thrust acceleration	1.41 g

4. Autopilot

Pitch Program, First Stage:

<u>Time (sec)</u>	<u>ω_p (deg/sec)</u>
0-15	0
15-27	0.96
27-39	0.76
39-64	0.64
64-79	0.72
79-89	0.68
89-105	0.40
105-120	0.28
120- t_g	0.24

Second Stage: 2 deg/sec, BECO + 5 to BECO + 24

Roll Program	32,467 deg
Yaw Program	None
Maximum dynamic pressure	874 lb/ft ² at 60 sec

5. Staging

BECO time	131.34 sec
Thrust acceleration at BECO	6.8 g's
Net positive suction head	28.4 ft
Inertial attitude angle	67.4 deg

6. Guidance/Radar

Mod III radar (primary):

Geodetic latitude	28.4475°N
Longitude	80.5820°W
Antenna phase-center above MSL	28.724 ft

Pitch look angle:

Start of guidance	-46° at 160 sec
SECO	-19.5° at 304 sec

Coordinates at SECO:

R_1	2,745,201 ft
A_1	72.39°T
E_1	7.43 deg

Bermuda station (secondary):

Latitude	32.35°N
Longitude	64.65°W

Coordinates at SECO:

R_2	2,639,053 ft
A_2	256.16°T
E_2	8.03 deg

7. Propellant Utilization

Computer comparator setting	2.28
Unexpended oxidizer	712 lb
Unexpended fuel	.312 lb

8. Quick Summary of Trajectory

<u>Event</u>	<u>Time</u> (sec)	<u>Altitude</u> (ft)	<u>Inertial</u> <u>Velocity</u> (ft/sec)	<u>Inertial</u> <u>Flight</u> <u>Path</u> <u>Angle</u> (deg)	<u>Weight</u> (lb)	<u>Surface</u> <u>Range</u> (naut mi)
Liftoff	0	-41.25	1,342	90.0	260,131	0.0
BECO	131.3	207,347	10,343	67.6	64,365	45.4
Booster Jettison	134.1	218,206	10,420	67.9	56,533	49.1
Tower Jettison	154.1	293,758	11,121	71.5	50,163	77.7
SECO/VECO	303.8	528,427	25,695	90.0	10,465	435.6

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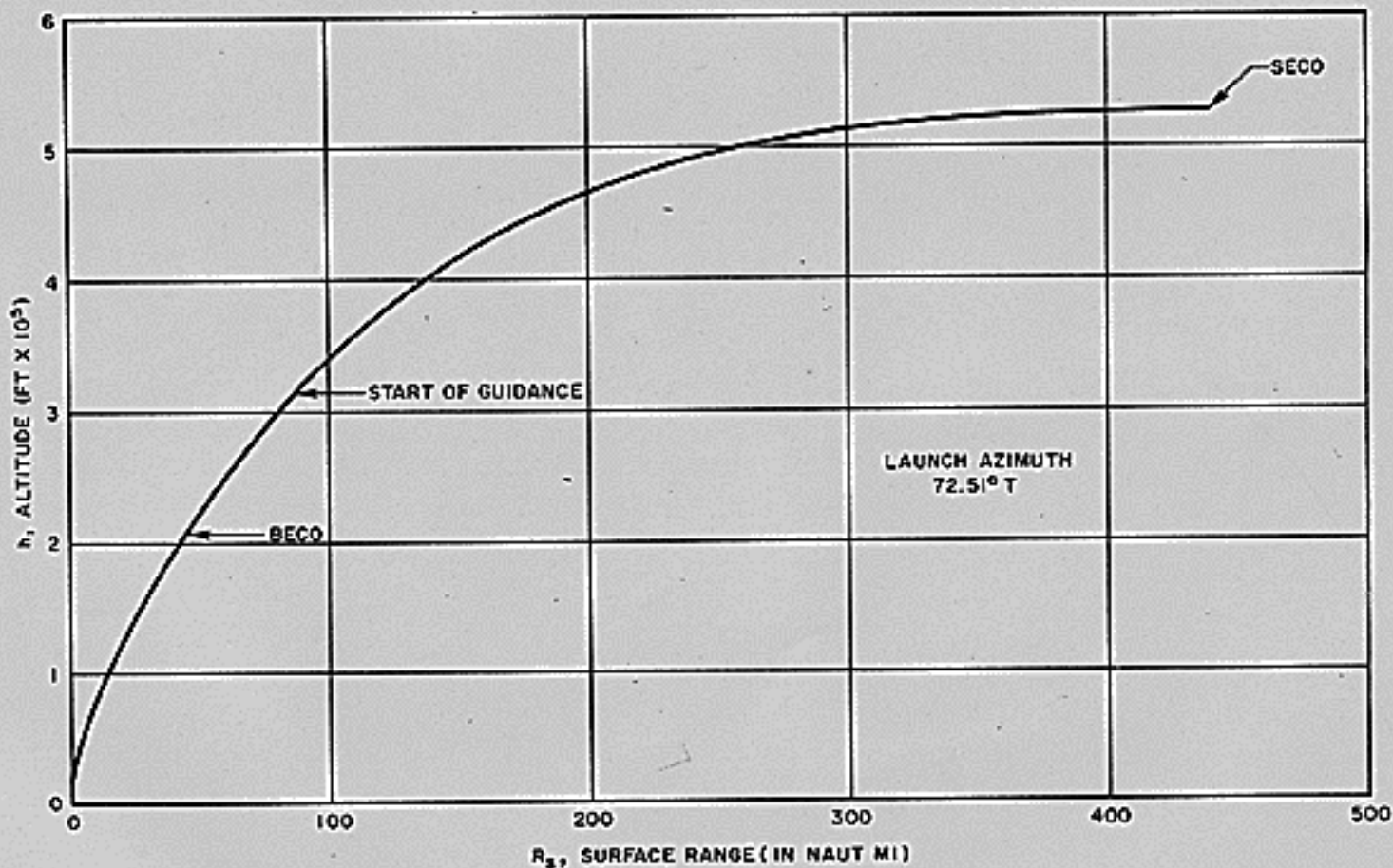


Figure B-1. Altitude vs Surface Range for Entire Booster Powered Flight Path

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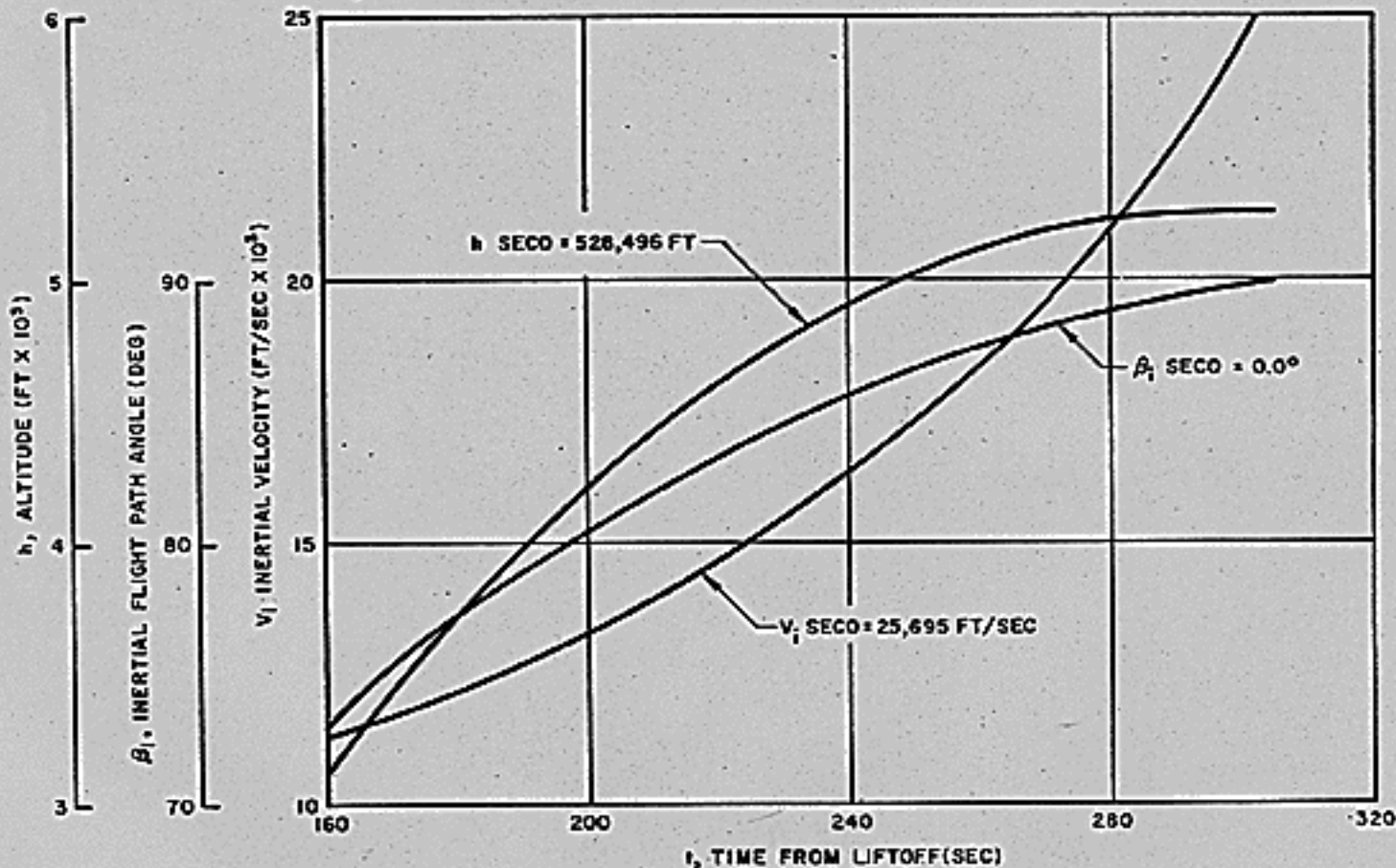


Figure B-2. Injection Parameters vs Time During Second Stage

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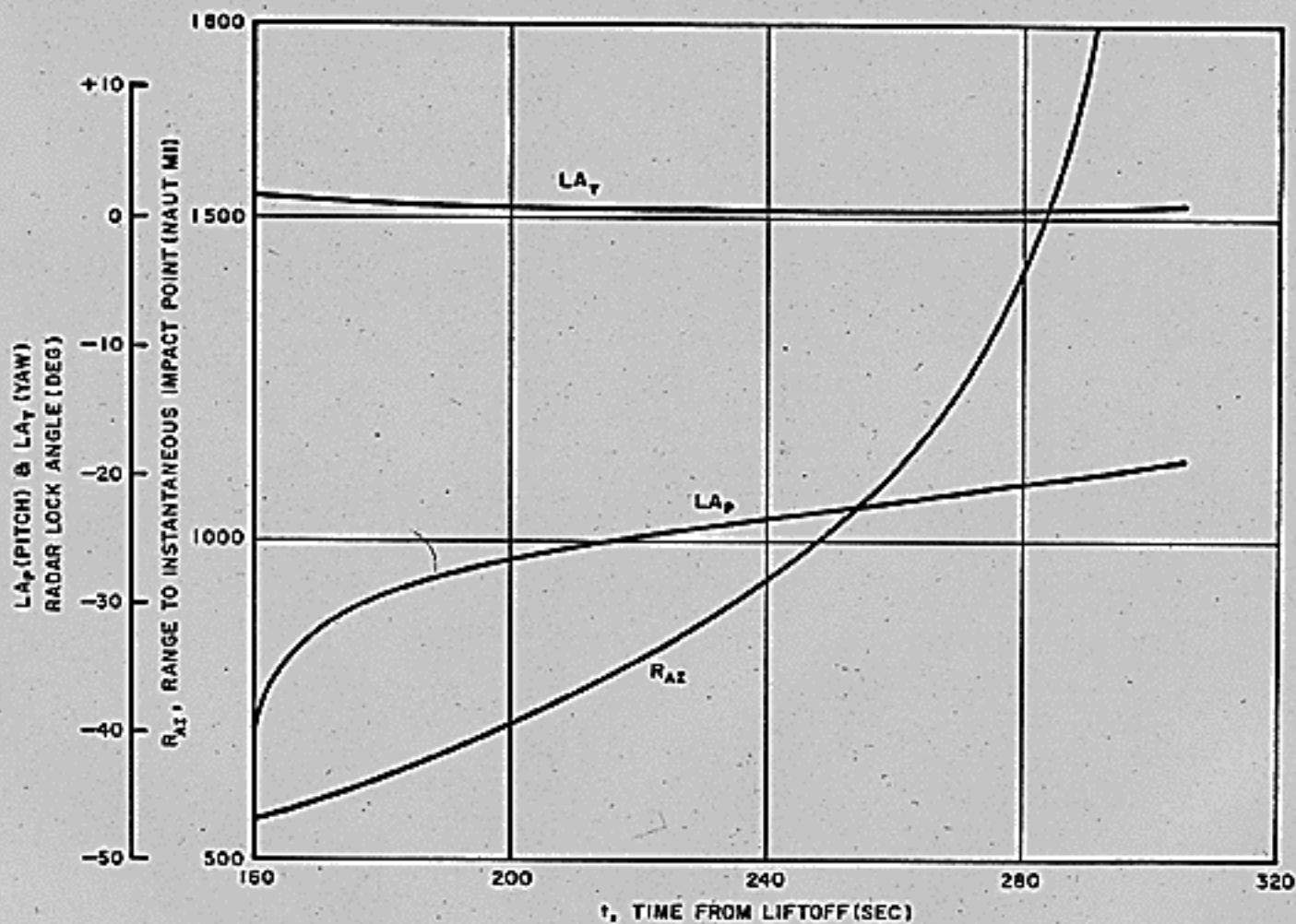


Figure B-3. Radar Look Angles and IIP Range vs Time During Second Stage

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LIFTOFF CASE W4

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	.0098918213	-1497.4023132	3	168929.0000	73596.000000	3
	366172.4179	2.335656851	4	4.309995114		4
	1.067641958	.0046840858	5	89.90959453	.0329459172	5
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	1342.140090	.0014337750	7	1342.140090	.0018633567	7
	1340777.1158	11.44953870	8	.0688879052	6.319807635	8
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	.0116788986	.0026151141	5	11817.51806	15415.93371	5
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	.00000000 00	.00000000 00	7	.00000000 00	.00000000 00	7
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	.0098918213	-1496.101776	3	158455.8417	69103.01953	3
	367795.6679	2.326520860	4	4.936323070		4
	804.1899108	.1306762602	5	1.245423421	24.69354605	5
	20910498.25	18405973.00	6	13417.13171	9923150.875	6
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20965624.25	18449304.25	6	131454.1152	9958077.500	6
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346971.5468	69.97127819	12	54.74741077	.7878904566	12
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.3795379959	.0803453345	3	.3399626538	.1483883858	3
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.00000000 00	.00000000 00	6	.00000000 00	-870.0015945	6
.00000000 00	.00000000 00	7	.00000000 00	.00000000 00	7

10 131.3423461	207346.5000	1	219.6440467	64364.92480	1
67.54861927	66.19481086	2	64.47789478	75.12558078	2
67.36336135	-1503.013320	3	32385.81811	14373.10864	3
439779.8750	2.309341669	4	28.44263052		4
402.0030517	9.003369569	5	1.741408020	19.69637703	5

21116949.00	18542457.50	6	443074.1718	10094874.75	6
10342.66528	2074.950714	7	9290.644775	4043.417541	7
208.7024803	17.84536147	8	191.5878734	80.82299423	8
45.40472364	278496.3828	9	532.8105468	205555.2773	9
9167.393920	8306.911254	10	16.51473999	3847.677215	10

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358880.6250	70.06056594	12	55.09228372	.8200707882	12
9007.469360	4.613922476	13	-2.462928533	28.55786561	13
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-7518.097351	.00000000 00	15	.00000000 00	497.2554626	15

180.0000000	.00000000 00	1	.00000000 00	.00000000 00	1
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.3824600801	.3921944424	4	.3939206265	.3906863555	4
.0074023306	.1480833553	5	11975.60839	291228.3046	5

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	.00000000 00	.00000000 00	6	.00000000 00	-870.0015945	6
	.00000000 00	.00000000 00	7	.00000000 00	.00000000 00	7
PRIMARY PHASE CUTOFF ---- GUIDANCE						
SUSTAINER						
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	67.54861927	66.19481086	2	64.47789478	75.12558078	2
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	80153.59179	1.951462060	4	.00000000 00		4
	402.0030517	9.003369569	5	1.741408199	19.69637703	5
	21116949.00	18542457.50	6	443074.1718	10094874.75	6
	10342.66528	2074.950714	7	9290.644775	4043.417541	7
	39.50845384	-19.44056677	8	34.33165884	2.078344702	8
	45.40472364	278496.3928	9	532.8105468	205555.2773	9
	9167.393920	8306.911254	10	16.51473999	3847.677215	10
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	358880.6250	70.06056594	12	55.09228372	.8200707882	12
	9007.469360	4.613922476	13	-2.462928533	28.55786561	13
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	180.0000000	.00000000 00	1	.00000000 00	.00000000 00	1
	1.055780202	.9272487387	2	.0136984341	.5046721473	2
	.3871864341	.0810962850	3	.3470203727	.1513723582	3
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	.00000000 00	.00000000 00	6	.0120000000	-870.0015945	6
	.00000000 00	.00000000 00	7	.00000000 00	.00000000 00	7
20	134.0973434	218206.0000	1	40.45234012	63633.00732	1
	67.90137672	66.12306785	2	64.89912605	75.13967990	2
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	10420.18078	2021.668914	7	9385.856201	4049.534088	7

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39.02606506	-19.24323060	8	34.78855276	2.360018770	8
49.13233089	301518.1679	9	576.8583984	216099.7871	9
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.3926668390	.0795183051	3	.3529409393	.1526328288	3
.3764137067	.3856936544	4	.3996984586	.3976462558	4
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SECONDARY PHASE CUTOFF ---- PHASE TIM					

JETTISON ONE

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	21127789.50	18548100.25	6	468800.7817	10106022.50	6
	10420.18078	2021.668914	7	9385.856201	4049.534088	7
	43.27649945	-18.24203062	8	38.99217510	4.437759399	8
	49.13233089	301518.1679	9	576.8583984	216099.7871	9
	9240.854980	8406.009643	10	15.37426757	3807.630798	10
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	1.056370571	.9275722876	2	.0148918308	.5052788034	2
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	.0073964326	.1478051804	5	11986.22106	316272.2382	5
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.0071678227	.1423940696	5	11986.20117	411288.4453	5

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	-4.304545283	-4.311103761	6	.0123131443	-870.0015945	6
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	10978.17395	1600.884902	7	10068.56530	4072.034332	7
	59.76046323	-37.97012662	8	45.99789285	-3.711654067	8
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	9771.242553	9119.243041	10	7.797302246	3473.180694	10
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SECONDARY PHASE CUTOFF ---- PHASE TIME

JETTISON TWO					
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	21203197.00	18583585.25	6	664962.2500	10187431.12 6
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-45.75059700	1.827711775	11	-0217820294	-59187195-04	11
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24 280.0000000	523346.5000	1	154.7194290	16781.82495	1
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21431511.75	18408817.25	6	2464503.812	10693501.37	6
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	.0147147487	.0147153031	4	.8509828523	.8430245966	4
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22410.11499	22274.49633	10	-122.1369628	-2458.682312	10
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24	300.5000000	528294.7500	1	229.0255222	11343.47351	1
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	2704053.218	-103.7203464	14	82.34115409	30.38580369	14
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	.00000000 00	.00000000 00	5	4.836777031	.00000000 00	5
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	25618.79418	-6787.631774	7	24231.50097	4804.689392	7

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250.0368309	-105.5102806	8	225.1398620	26.42047166	8
434.3498573	2699003.125	9	-7041.843750	358103.9257	9
24302.49902	24111.77880	10	-138.5085449	-3035.520629	10
-19.48340773	1.119044795	11	.0012340821	.59217934-03	11
2737928.500	72.38786220	12	82.52594089	7.997987985	12
23507.25048	.4976049401	13	-.2974404953	30.25500011	13
2646288.687	-103.8258714	14	82.00942802	30.42274737	14
-23389.24023	.00000000 00	15	.00000000 00	.00000000 00	15
.3088893667	-.95597643-03	1	.46261910-03	.0040218385	1
1.071812331	.9167404920	2	.1293712575	.5400293097	2
.9656460508	-.2360747829	3	.9186584800	.1811286900	3
.23526035-03	.23526035-03	4	.9959918707	.9803781435	4
-.23025274-03	.22717823-03	5	239.0985183	2714631.750	5
-.0079387305	-.0079521205	6	.0126939973	-870.0015945	6
-.0621395819	-.2034922596	7	-.0093415640	.0801146831	7
24 303.8088836	528428.5000	1	248.2748394	10465.42944	1
90.00000953	94.77150440	2	90.00001049	77.47564983	2
103.0477485	-265.3733177	3	711.7471771	311.6847572	3
00723.72851	2.283557921	4	.00000000 00		4
.00000000 00	.00000000 00	5	4.828515827	.00000000 00	5
21436244.00	18272729.25	6	2988990.750	10802123.12	6
25695.03588	-6820.325683	7	24301.31909	4812.891052	7
251.9530715	-106.1783781	8	226.9238796	26.68437933	8
435.5565261	2706462.312	9	-7044.757812	357162.8867	9
24378.74560	24185.78613	10	-139.2315063	-3058.036193	10
-19.46438813	1.129158660	11	.0012340821	.59217934-03	11
2745201.125	72.38906955	12	82.56577110	8.020636677	12
23581.98022	.4955102764	13	-.2952637188	30.25959563	13
2639053.093	-103.8394393	14	81.96722698	30.42735791	14
-23460.87988	.00000000 00	15	.00000000 00	.00000000 00	15
.3088893667	-.95597643-03	1	.46261910-03	.0040218385	1
1.071812331	.9167404920	2	.1293712575	.5400293097	2
.9656460508	-.2360747829	3	.9186584800	.1811286900	3
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-.23025274-03	.22717823-03	5	239.0985183	2714631.750	5
-.0079387305	-.0079521205	6	.0126939973	-870.0015945	6
-.0621395819	-.2034922596	7	-.0093415640	.0801146831	7

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Printout Key Definitions

t	Time from Z" motion, sec
h	Altitude above (DOD WGS-60) reference ellipsoid along radius vector, ft
a_t	Thrust acceleration ($\frac{F - D}{M}$) during powered flight or atmospheric deceleration ($\frac{D}{M}$) during free flight, ft/sec ²
W	Weight, lb
β_i	Inertial flight path angle, radius vector (extended) to inertial velocity vector, deg
θ_i	Pitch angle, radius vector (extended) to roll axis, deg
β	Flight path angle, radius vector (extended) to aerodynamic velocity vector, deg
$A_z V_i$	Azimuth of inertial velocity vector from North, deg
e	Inertial pitch angle, launcher radius vector (extended) at liftoff to roll axis, deg
$\dot{W}$	Propellant weight flow rate, lb/sec
W_L, W_F	Weight of expendable lox and fuel remaining, lb
F	Thrust, lb
μ	Mixture ratio, lox flow rate to fuel flow rate
NPSH	Net positive suction head at sustainer lox pump inlet, ft
F_{NT}	Total normal force, lb
D	Drag force, lb
M	Mach number
α	Angle of attack, roll axis to aerodynamic velocity vector, deg
q	Dynamic pressure, lb/ft ²
r	Radius vector magnitude, distance to center of earth, ft

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x, y, z	Position in inertial, rectangular coordinates (components of r); origin at center of earth, x-y plane contains equator, x-z plane contains polar axis and launcher at $t = 0$, x-positive at launch, y-positive eastward, z-positive northward, ft
V_i	Inertial velocity magnitude, referred to ECI (earth-centered-inertial, x-y-z) coordinate system, ft/sec
$\dot{x}, \dot{y}, \dot{z}$	Inertial velocity components, ft/sec
a	Acceleration magnitude referred to ECI coordinate system, ft/sec ²
$\ddot{x}, \ddot{y}, \ddot{z}$	Acceleration components, ft/sec ²
R_s	Distance from launcher to projection of missile on spherical earth (approximate surface range), naut mi
u, v, w	Position in rectangular, earth-fixed coordinates; origin at launcher, u-v plane normal to local gravity vertical, u-w plane contains vertical and launch azimuth, u-positive downrange, v-positive left looking downrange, w-positive up, ft
V_A	Aerodynamic velocity magnitude, referred to air mass, ft/sec
$\dot{u}, \dot{v}, \dot{w}$	Components of velocity with respect to earth, ft/sec
LA_p	Pitch look angle, rearward roll axis to pitch plane projection of radar line-of-sight, clockwise from right, deg
LA_y	Yaw look angle, rearward roll axis to yaw plane projection of radar line-of-sight, clockwise from below, deg
ω_p, ω_y	Pitch and yaw angular velocity, pitch-positive downward, yaw-positive right looking downrange, rad/sec

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Γ	Sine of angle between inertial velocity vector and plane normal to radius vector
Γ_o	Flight path angle for NASA display, rad
$V/V_R, (V/V_R)_N$	Velocity ratios for NASA display
V_y	Yaw velocity error, multiply by 26,530 to get ft/sec
V_p	Radial component of inertial velocity, multiply by 26,530 to get ft/sec
y, d	Position, converted from radar inputs; similar to u-v-w system with origin at radar, uses radar radius vector and line directed toward expected burnout point as axes; y-crossrange, positive right, d-positive downrange, ft
V_N	An exponential function of velocity-to-be-gained, linear in time and zero when V reaches desired value
$\bar{V}_N$	Smoothed V_N
$\dot{\bar{V}}_N$	Smoothed rate-of-change of V_N
h_{ins}	Predicted burnout radius vector magnitude minus computer value for earth radius, naut mi
β_p, β_y	Pitch and yaw attitude components used to compute steering commands, rad
$\bar{\beta}_p, \bar{\beta}_y$	Desired values of β_p and β_y , rad

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Printout Key

Project Mercury Trajectories

Powered-Flight Line Numbers

1

 t h a_t W

2

 β_1 α_1 ρ $A_E V_1$

3

 e $\dot{W}$ W_L W_F

4

 F μ

NPSH

5

 D M ϵ q

6

 r x y z

7

 V_1 $\dot{x}$ $\dot{y}$ $\dot{z}$

8

 a $\ddot{x}$ $\ddot{y}$ $\ddot{z}$

9

 R_s u v w

10

 V_A $\dot{u}$ $\dot{v}$ $\dot{w}$

11

 LA_p LA_y ω_p ω_y

12

 R_1 A_1 E_1 λ

13

 R_1 P_1 $\dot{O}_2$ ϕ_r

14

 R_2 A_2 E_2 ϕ_g

15

 R_2 P_2 $\dot{O}_2$ R_{AI}

1

 T_n ω_{pn} ω_{yn} ω_{ph}

2

 r ξ η ζ

3

 v $\dot{\xi}$ $\dot{\eta}$ $\dot{\zeta}$

4

 r r_o V/V_R $(V/V_R)N$

5

 V_y V_p y d

6

 V_N $\bar{V}_N$ $\dot{V}_N$ h_{ins}

7

 β_p $\bar{\beta}_p$ δ_y $\bar{\beta}_y$

Free-Flight Line Numbers

1

2

3

4

5

6

7

8

9

10

11

12

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APPENDIX C
PILOT SAFETY PROGRAM

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APPENDIX C
PILOT SAFETY PROGRAM

- C.1 The fundamental concept of the Mercury vehicle involves the adaptation of the Atlas missile to the requirement of boosting a manned satellite into orbit around the earth. Because the Atlas was conceived as a ballistic missile, it was not designed in accordance with the requirements laid down for piloted aircraft. It is for this reason that the Pilot Safety Program for Project Mercury was conceived. This program is intended to insure maximum safety for the Mercury astronauts during their flights using the Atlas missile.
- C.1.1 The three major areas of the Pilot Safety Program are a Quality Assurance Program, a Factory Rollout Inspection, and Flight Safety Review at AMR.
- C.1.1.1 The Quality Assurance Program (see Reference i) will provide for the following:
- a. Educational program for contractor personnel
 - b. Selection of individual components and subsystems
 - c. Selection of engine clusters
 - d. Allocation of selected spares
 - e. Component identification
- C.1.1.2 The Factory Rollout Inspection purpose is to assure that the Atlas Booster is complete in configuration, functionally acceptable, and ready for delivery to the USAF (Reference j). The scope of the activity will comprise a complete review of the composite and system test data, documentation of selected components and subsystems, shortage status and Air Force discrepancy reports. It will include visual inspection of the booster.

A carefully selected team from AFSSD/Aerospace with representatives for various subsystem areas and from the Air Force Plant Representative (AFPR) Quality Control will perform the Factory Rollout Inspection.

- C.1.1.3 The Flight Safety Review objective at AMR is to determine the flight readiness of the booster and its compatibility with the Mercury capsule (see Reference k). The Flight Safety Review is a continuous effort from the time the missile arrives at AMR until the missile is launched.

C.1.2 Organization and Responsibilities

The activities of the Flight Safety Review will take place at several levels. Working Teams, Interface Committee, Active Review Team, Status Review Team and the Booster Flight Safety Review Board.

Working Teams - the activities of these teams are divided into such areas as propulsion, airframe and hydraulics, electrical, guidance, telemetry, flight control, etc. Each team will be chairmanned by Aerospace/AMR and will consist of a representative from Aerospace/AMR, BSD/AMR, AFSCTSO and GD-A. Associate contractors will be represented where appropriate. It is the responsibility of these teams to observe and monitor all activities in their respective areas, to assure proper documentation, and to report their findings and recommendations to the Active Review Team.

Interface Committee - this team, chairmanned by NASA, will consist of a representative from Aerospace/AMR, BSD/AMR, AFSCTSO, NASA, McDonnell and GD-A. This team shall assure the quality of workmanship, eliminate interference, and assure that the interface area is clear of any defects or debris which could jeopardize the flight.

Active Review Team - this team, chairmanned by Aerospace/AMR, will consist of representatives from Aerospace/AMR, BSD/AMR, and AFSCTSO. The functions of the team are to continuously review and document the over-all progress of the missile, to make

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Page C-3

necessary decisions based on the recommendations of the working teams, and to insure that the work is progressing satisfactorily in accordance with the basic philosophy of the Flight Safety Review. The team will be responsible for the preparation of a summary report covering the history of the booster from factory acceptance to X-1 day.

Status Review Team - this team, chaired by the 6555th Test Wing will consist of representatives from the 6555th Test Wing, NASA, AFSCSO, Aerospace/L. A., Aerospace/AMR, Burroughs, AFSSD/L. A., GE/DSD, GD-A and Rocketdyne. The team shall perform the X-1 Day status review to determine the technical readiness of the missile for flight. Based on the review, a go or no-go recommendation will be transmitted to the Booster Flight Safety Review Board, chaired by AFSSD/L. A.

Booster Flight Safety Review Board - the board, chaired by AFSSD/L. A., will consist of a representative from Aerospace/L. A., Aerospace/AMR, BSD/AMR, AFSSD/L. A., and NASA. It is the responsibility of the Board to accept or reject the recommendation presented to it by the Status Review Team.

NOTE: These teams and boards complement the weekly activity of the Mercury Booster Working Group and the AMR coordination body chaired by 6555th Test Wing/Aerospace, AMR. (Reference: Ltr from Colonel P. R. Wignall, Commander 6555th Test Wing, dated 17 April 1961, subject: Space Launch Coordination Board.)

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J. F. Wambolt

JAN 2 1962

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* **FLIGHT PLAN**

FOR

MERCURY-ATLAS MISSION 6

*Who has priority
for Astro contact
between HTS + KNO
on 2nd orbit?*

*File
copy*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Langley Air Force Base, Va.

December 21, 1961

*D: 12-21-61 NSC N100 of MER *FLIGHT...6 NSC R22012
MA-6*

MA-6 FLIGHT PLAN

Attached is a revised copy of the MA-6 Flight Plan. This supercedes the Flight Plan dated December 6, 1961.

This Flight Plan includes the Flight Plan Mission Rules, the MA-6 Flight Plan, a set of ground station pass procedures, and a set of references detailing sections of the Flight Plan.

Any recommendations for changes should be transmitted to:

Mr. David B. Pendley
NASA Manned Spacecraft Center
Flight Operations Division
Spacecraft Operations Branch
Flight Activities Section
Langley Air Force Base, Va.

or

Captain Robert D. Mercer
Project Mercury Field Operations
Hangar S, Stop No. 24
Port Canaveral, Fla.

MA-6 FLIGHT PLAN

Standard reports during powered flight every 30 seconds.
Report: Fuel, cabin pressure, O₂ quantity, amps, comments.

00:02:11 Report BECO
00:02:34 Report tower attention
00:04:20 CapCom reports MCC is GO
00:04:30 Astro reports he is GO
00:05:04 Report BECO - Cap Sep
00:05: - Report turnaround and retro attitude
00:05: - CapCom reports "GO" condition - orbit capability and Astro reports switch positions
00:06:00 BDA gives Astro retrofire times. CET check
00:08:00 Control systems check - check all control modes.
00:16:30 Blood pressure measurement over CYI
00:24:00 60° yaw maneuver to check ability to determine yaw ref thru periscope.
00:28:00 Dark side checklist - includes control sys. warmup and check. (All axis MP and FBW)
00:30:00 Make 30 minute report to ZEB
00:43:00 Night horizon check - checks reference capability at night using window pitch, roll, and yaw maneuver
00:44:00 IOS flare observation - CET check
00:54: - Astro maintains 0, 0, 34 on FBW to determine capability on dark side.
00:56:00 30 minute report. Blood pressure, vision test, exercise etc.
01:04:00 All stations HF check
01:10:10 Star navigation capability.
01:12:00 First meal
01:16:00 Go thru pre-retro checklist
01:2--- Observe sunrise. Go to ASCS in preparation for GO NO-GO decision at CYM
01:34:00 30 minute report to MCC
01:40:00 CET check, HF check from Astro
01:41:00 Occulogyric test over BDA
01:44:00 All stations HF check
01:49:00 Day horizon check - checks reference capability, in daylight using window pitch, roll, and yaw maneuver
01:54:00 180° yaw maneuver (Gyro's free)
02:01:00 30 minute report to ZEB
02:14:00 IOS flare observation
02:17:00 Star tracking
02:28:00 Observe cities if possible
02:29:00 30 minute report, blood pressure, vision, exercise, etc.
02:37:00 Night observations and star tracking, star observations, etc.
02:45:00 Second meal on ASCS
02:53:00 Go thru pre-retro checklist
03:05:00 Go to ASCS - make GO NO-GO decision on 3rd orbit
03:07:00 30 minute report - blood pressure, etc.
03:09:00 Weather observation
03:25:00 30 minute report - blood pressure, etc.
03:37:00 Night observations - stars, etc.
03:56:00 30 minute report - command voice check
04:15:00 Begin preparation for retrofire
04:18:00 Occulogyric test
04:20:00 Thruster warmup of Man. Cont. Sys.
04:22:00 Go thru equip. stowage and pre-retro checklist with HAW CapCom.
04:30:00 Exercise - ready to control retrofire
04:32:28 Retro sequence
04:32:58 Retrofire on ASCS - Man backup
04:41:00 MCC give IP, recovery time, etc.

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MA-6 FLIGHT PLAN (FIRST ORBIT)

Time	Activity	Sta.	Radio	Mode	Comments
0:00:00	Lift-off	MCC	UHF H1	ASCS	Spacecraft Status: EPI is running, periscope is in, window shutters - open, D-C voltmeter - isol. bus Report: Clock operating
0:00:30	Report	MCC	UHF H1	ASCS	A: Fuel, cabin pressure, O ₂ , amps MCC: Pitch NOTE: Spacecraft pitch information is not available to MCC; the figure given is the nominal pitch.
0:01:00	Report	MCC	UHF H1	ASCS	A: Fuel, cabin pressure, O ₂ , amps, <u>tower vibration.</u> MCC: Pitch
0:01:30	Report	MCC	UHF H1	ASCS	A: Fuel, cabin pressure, O ₂ , amps MCC: Pitch
0:02:00	Report	MCC	UHF H1	ASCS	A: Fuel, cabin pressure, O ₂ , amps MCC: Pitch
0:02:11	BECO	MCC	UHF H1	ASCS	A: Reports BECO, his own status MCC: Pitch

December 21, 1961

*Is Shepard
to give this
?*

Time	Activity	Sta.	Radio	Mode	Comments
0:02:34	Jett Tower	MCC	UHF H1	ASCS	A: Report Jett Tower green, Auto Retro Jett - off, Retro Jett Fuse Switch - off MCC: Pitch NOTE: HF can be activated now
0:03:00	Report	MCC (BDA)	UHF H1	ASCS	A: Fuel, cabin pressure, ^{holding} O ₂ , amps MCC: Pitch (BDA): Advise when voice and T/M is solid
0:03:30	Report	MCC (BDA)	UHF H1	ASCS	A: Fuel, cabin pressure, ^{holding} O ₂ , amps, complete voltage check MCC: Pitch
0:04:00	Report	MCC (BDA)	UHF H1	ASCS	A: Fuel, cabin pressure, ^{holding} O ₂ , amps MCC: Pitch
0:04:20	Report	MCC	UHF H1	ASCS	MCC: Control Center "go"
0:04:30	Report	MCC (BDA)	UHF H1	ASCS	A: Fuel, cabin pressure, ^{holding} O ₂ , amps, systems "go" checks MCC: Trajectory good <u>Astro is go</u>

December 21, 1961

RV-2 KNIGHT RYAN (ALPHA ORANGE)

Time	Activity	Sta.	Radio	Mode	Comments
0:05:05	Sep Cap Turnaround complete	MCC (BDA)	UHF H1	ASCS	A: Sep Cap green, Aux Damp OK, periscope out, turnaround started, ASCS OK, electrical system check, tumbling sensation May occur at BDA { When orbit "go" received: Retro Delay - normal, Ldg Bag Switch - off, Emer Retro Seq Fuse Switch - off, Droque Fuse Switch - off, Retro Manual Fuse Switch - off } VOX power - on
0:06:15	BDA hand-over (Orbit attitude)	BDA	UHF H1	ASCS	1. Get retro times 1B, 1st and 3rd orbit. Check retro times with onboard charts. 2. Check CET clock and wrist watch. (is BDA to give time back?) 3. BDA: Give command voice count. - Why do this if UHF OK. 4. A: Report booster motion, initial Og sensations MCC: Your V/V_R is _____. (FIDO GIVE TO CAPCOM)
0:08:00 on ASAP AFTN 0:06:15 Activity	Control systems check	BDA	UHF H1	As reqd.	For control systems check see reference no. 4.
0:10:00	Communications change		HF	Optional	Astronaut switches to HF on LOS of BDA.
0:13:00	Remove chest strap		HF	Optional	

December 21, 1961

Start out with retro delays as in normal position?

Time	Activity	Sta.	Radio	Mode	Comments
0:14:00	Communications change	CYI	UHF H1	Optional	Astronaut switches to UHF H1 upon completion of HF check with either BDA or CYI. <i>CYI reports computer accepting radar data.</i>
0:14:20	Radar tracking and spacecraft status report	CYI	UHF H1	ASCS	CYI reports when radar lock is See spacecraft status section of reference 11.
0:16:30	Observation and Blood Pressure	CYI	UHF H1	ASCS	The spacecraft is approaching the coast of Africa. See reference no. 21. For blood pressure check see reference no. 11.
0:18:00	Observation	CYI	UHF H1	ASCS	The astronaut will mark crossing the coast (see reference no. 21) He checks the EPI.

December 21, 1961

Time	Activity	Sta.	Radio	Mode	Comments
0:21:00 (0:21:00)	Communications change	CYT	UHF Lo	Optional	The astronaut switches to UHF Lo. During warmup of UHF Lo continues his observation. (He will return to UHF H1 immediately following the UHF-Lo check.)
0:21:00	Possible overlap KNO-CYT	KNO	UHF Lo for check UHF H1	Optional	See reference no. 13. Return UHF H1 following UHF-Lo check. <i>Astro gets retrofire time for Area 1C.</i>
0:24:00	Yaw maneuver	KNO	UHF H1	FEW	See reference no. 5.
0:28:00	ASCS check Dark side checklist	KNO	UHF H1	ASCS	See reference no. 14.
0:30:00	30-Minute Report	ZZB	UHF H1	ASCS	See reference no. 11. Report begins when contact solid. <i>T/M</i> <i>Astro gets retrofire time for Area 1D.</i>
0:33:48	Retrofire time for contingency area 1C	ZZB	UHF H1	ASCS	

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Time	Activity	Sta.	Radio	Mode	Comments
0:34:00	Sunset 0930 launch	ZZB	UHF	ASCS	Observe sunset. Put comments on tape.
0:36:00	Sunset 0830 launch	ZZB	UHF H1	ASCS	Observe sunset. Put comments on tape.
0:40:30	Sunset 0730 launch	IOS	UHF H1	ASCS	Should read IOS by now. <i>also get retroreg. times for Ahead 1 E, F and H.</i>
0:43:00	Night horizon check	IOS	UHF H1	MP	Astronaut switches to manual control and performs control check (see reference no. 23).
0:44:00		IOS	UHF H1		Approximate time of flare ignition. <i>Note how flare is to be operated.</i>
0:44:00 (night)	Observation Time check	IOS	UHF H1	Optional	The astronaut checks his watch against CET. <i>Ground (IOS) Gives GET (Maybe better over ZZB or MUC)</i>

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Time	Activity	Sta.	Radio	Mode	Comments
0:49:00 (night)	Ground report	MUC	UHF H1	Optional	Obtain orbit information from ground, i.e., eccentricity, etc. (FIDO Give to FD for trans to MUC) (Maybe put on TTY after receive on CYI Data)
0:51:00 (night)	Switch to ASCS Observation	MUC	UHF H1	ASCS	See reference no. 18. See reference no. 20. See reference no. 21.
0:51:54 (night)	Retro time ^{SP} time for contingency area 1D	MUC		ASCS	
0:54:20 (night)	Radar tracking Handover to WCM as soon as possible	MUC	UHF H1	FEW	Hold 0° roll, 0° yaw, -34° pitch for for radar track. MUC: Gives inverter temperatures Begin HF check at a CET of _____ See reference no. 13.
0:56:20 (night)	Start 30-min report	WCM	UHF H1	ASCS	The astronaut begins the 30-minute report. (See blood pressure, exercise, and vision portions of reference no. 11).
1:00:00 (night)	End 30-min report	WCM	UHF H1	ASCS	The astronaut completes the remainder of the 30-minute report (see reference no. 11).

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Time	Activity	Sta.	Radio	Mode	Comments
1:03:30 (night)	Communications change	WOM	HF	ASCS	After UHF H1 contact lost, astronaut switches to HF.
1:04:00 (night)	All stations HF check	WOM	HF	ASCS	See reference no. 12.
1:10:00 (night)	Star navigation	CTN	UHF H1	ASCS	See reference no. 18. (Astronaut returns to UHF H1 at 1:08)
1:12:00 (night)	First meal	CTN	UHF H1	ASCS	A: Reports taste and smell sensations. Continues observations. CTN: Instruct astronaut to prepare for a possible reentry. Go through pre-retro seq check list between CTN & GYM & report complete at GYM.
1:16:00	Begin preparation for possible reentry	CTN	HF	ASCS	Equipment stowage checklist (reference no. 6) Preretrofire checklist (reference no. 7) (After UHF H1 contact is lost astronaut switches to HF at approx. 1:16)
1:16:18	Retro seq seq time for contingency area 1E	CTN	HF	ASCS	

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Time	Activity	Sta.	Radio	Mode	Comments
1:18:00	Sunrise 0930 launch				Astronaut transmits sunrise remarks.
1:24:00	Sunrise 0830 launch				Astronaut transmits sunrise remarks.
1:25:00	Communi- cations change		UHF H1	ASCS	Astronaut switches to UHF H1. <i>30 sec. prior to Retrosequence Time</i>
1:27:00	Go-No-Go decision	GYM (CAL)	UHF H1	ASCS	At 1:27:00 contact (2:12) a Go-No-Go decision is made between spacecraft and ground. <i>Astro gets retroseq. time for ahead 2A, G, and H.</i>
1:29:00	Sunrise 0730 launch	TEX	UHF H1		
1:29:06	Retro ^{sequence} time for contingency area F	GYM TEX		ASCS	

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MA-6 FLIGHT PLAN (SECOND ORBIT)

Time	Activity	Sta.	Radio	Mode	Comments
1:40:00	CET check	BDA	UHF H1	Optional	CYI: Begin HF check at a CET of _____ (See reference no. 12)
1:41:00	Oculogyric test	BDA	UHF H1	FBW	See reference no. 16.
1:43:00	Communications change		HF	Optional	Astronaut switches to HF after loss of BDA and prior to HF check at 1:44:00.
1:44:00	All stations HF check		HF	Optional	See reference no. 12.
1:47:30	Communications change	CYI	UHF H1	Optional	Astronaut returns to UHF H1 prior to contact with CYI.
1:49:00	Day horizon check	CYI	UHF H1	MP	See reference no. 23.

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Time	Activity	Sta.	Radio	Mode	Comments
1:51:06	^{58p.} Retrofire time for con- tingency area 2B	CYT	UHF H1	Optional	The spacecraft should be near retroattitude.
1:54:00	180° yaw maneuver	ATS	UHF H1	Optional	Yaw the spacecraft 180° and observe the land ahead of the spacecraft through the window. Gyros in the free position (4 minutes maximum duration).
1:55:00	Predark side check	ATS and KNO	UHF H1	Optional	See reference no. 14.
2:01:00 (night)	30-minute standard report	ZZB	UHF H1	ASCS	See reference no. 11. ZZB reports when T/M solid. Sunset 0930 launch.
2:04:00 (night)	Sunset 0830 launch	ZZB	UHF H1	ASCS	Possible turnaround to observe sunset.
2:07:36 (night)	^{58p.} Retrofire time for con- tingency area 2C	ZZB		ASCS	

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W-2 BRIGEL DATA (SECOND ORBIT)

Time	Activity	Sta.	Radio	Mode	Comments
2:08:00 (night)	Sunset 0730 launch	ZZB	UHF H1	Optional	
2:14:00 (night)	Observation of flare from IOS	IOS	UHF H1	Optional	<i>Astron gets retroseq. timed for area 2D, 2E, and G.</i>
2:17:00 (night)	Star tracking	IOS	UHF H1	Optional	See reference no. 19. Hold position on a star reference. ^{Approximate} time of flare ignition.
2:24:00 (night)	Orbit position information <i>night observation of cities</i>	MUC	UHF H1	Optional	Check of orbit position, angle, and eccentricity delayed to astronaut. MUC gives inverter temperatures.
2:28:00 (night)	Night observation of cities	MUC (WOM)	UHF H1	ASCS	See references nos. 20 and 21.
2:28:54	^{See} Retroseq time for contingency area 2D	MUC (WOM)		ASCS	

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Time	Activity	Sta.	Radio	Mode	Comments
2:29:00 (night)	Blood press., vision, and standard 30- minute report	WOM (MUC)	UHF H1	ASCS	See reference no. 11. WOM reports when T/M solid.
2:35:00	Communi- cations change		HF	Optional	After UHF H1 contact lost astronaut switches to HF.
2:37:00 (night)	Night obser- vations and star tracking		HF	Optional	See references nos. 18, 19, 20, and 21.
2:44:00	Communi- cations change		UHF H1		Astronaut switches to UHF H1.
2:45:00 (night)	Eat	CTN	UHF H1	ASCS	Note changes in taste and smell.. Stay on ASCS during eating period.
2:46:00	Sunrise 0930 launch	CTN	UHF H1	Optional	

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Time	Activity	Sta.	Radio	Mode	Comments
2:49:18	Retro ³⁵⁵ 255 time for contingency area 2E	HAW		Optional	Spacecraft attitude should be near retroattitude.
2:52:00	Observations and sunrise 0830 launch	HAW	UHF H1	Optional	See references nos. 20 and 21.
2:53:00	Prepare for possible reentry	HAW	UHF H1	Optional	Begin equipment stowage and preentry checklists. See references nos. 6 and 7.
2:57:00	Sunrise 0730 launch	CAL	UHF H1	ASCS	Astronaut switches to ASCS prior to contact with CAL.
2:58:00	Go-No-Go	CAL	UHF H1	ASCS	Decision point on this orbit. 30 sec. prior to RETROSEQUENCE TIME A GO-NOGO decision is made BETWEEN SPACECRAFT AND GROUND. <i>Retros given retroseq. times for areas 3A and H.</i>
3:00:48	Retro ³⁵⁵ 255 time for contingency area G			ASCS	

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MA-6 FLIGHT PLAN (THIRD ORBIT)

Time	Activity	Sta.	Radio	Mode	Comments
3:07:00	Blood press., vision, and standard 30-minute report	MCC (TEX)	UFH H1	ASCS	See reference no. 11. MCC reports when T/M solid. MCC gives inverter temperatures. <i>Aster gets retroseq. timer for areas 3B and 3C.</i>
3:09:00	Weather observation	MCC	UFH H1	ASCS	See reference no. 20.
3:10:30	Retro seq. ^{cs.} time for contingency area 3A	MCC		ASCS	
3:16:30	Communications change		HF		After UHF H1 contact is lost with BDA astronaut switches to HF.
3:23:48	Retro seq. ^{cs.} time for contingency area 3B			Optional	Spacecraft should be near retroattitude.
3:25:00	Communications change	ATS	UFH H1	Optional	Astronaut switches to UHF H1 prior to contact with ATS.

Time	Activity	Sta.	Radio	Mode	Comments
3:25:00 (night)	Blood press., vision, and standard 30-minute report	ATS	UHF H1	ASCS	See reference no. 11. Sunset 0930 launch. Astronaut switches to ASCS on contact with ATS. ATS reports when T/M solid.
3:25:00 (night)	Predark side check	ATS	UHF H1	ASCS	See reference no. 14.
3:32:00 (night)	Sunset 0900 launch		HF	Optional	Spacecraft should be near retroattitude.
3:33:00 (night)	Sunset 0830 launch		HF	Optional	Spacecraft should be near retroattitude.
3:33:30 (night)	Communications change	ATS	HF	Optional	Astronaut switches to HF upon LOS from ATS.
3:37:00 (night)	Sunset 0730 launch		HF	Optional	Begin observations. See references nos. 18, 19, 20 and 21. LOS UHF contact may be expected from 3:47:00 to 3:54:00 during these observations.

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Time	Activity	Sta.	Radio	Mode	Comments
3:41:00 (night)	Retro ⁵²⁸ time time for con- tingency area 3C		HF	Optional	Spacecraft should be near retroattitude.
3:46:00 (night)	Communi- cations change	IOS	UHF H1		Astronaut switches to UHF H1. <i>Retro gets retroseq. timer for areas 3D, 3E, and H.</i>
3:56:00 (night)	Command voice check. Blood pressure, vision and standard 30- minute report.	MUC (WOM)	UHF H1	ASCS	MUC reports when T/M solid. See reference no. 11. MUC gives inverter temperatures. Astronaut on ASCS while giving report.
4:05:36 (night)	Communi- cations change	WOM	HF		After UHF H1 contact is lost the astronaut switches to HF.
4:05:36 (night)	Retro ⁵²⁸ time time for con- tingency area 3D	WOM	HF	Optional	Spacecraft should be near retroattitude.
4:14:00	Sunrise 0930 launch		HF	Optional	

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Time	Activity	Sta.	Radio	Mode	Comments
4:15:00	Begin preparation for retrofire		HF	Optional	
4:17:00	Sunrise 0900 launch		HF	Optional	
4:18:00	Oculogyric test		HF	FEW	See reference no. 16.
4:20:00	Thruster warmup		HF	MP	Sunrise 0830 launch.
4:21:00	Communications change		UHF H1	Optional	Astronaut switches to UHF H1.
4:22:00	Equipment stowage checklist followed by preretrofire checklist	HAW	UHF H1	Optional	Last time check. See references nos. 6 and 7. <i>CAPCOM counts down to GET "MARK".</i>

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Time	Activity	Sta.	Radio	Mode	Comments
4:22:18	Retro ^{SEA} time time for con- tingency area 3E	HAW	UHF H1	Optional	
4:25:00	Sunrise 0730 launch	HAW	UHF H1	Optional	
4:30:00	Exercise		UHF H1	ASCS	Ready to control retros ^{sequence} time .
4:32:00	Retro ^{sequence} time	CAL	UHF H1	ASCS	As in MISSION Rules.
4:34:00	Exercise and blood press. test	CAL (GYM)	UHF H1	ASCS	
4:41:00	Splash and retrieval information	MCC	UHF H1	ASCS	MCC gives following: Impact prediction, elapsed time to recovery, wind velocity, air temperature, and wave height.

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Time	Activity	Sta.	Radio	Mode	Comments
5:55:43	4th orbit retro time <i>sf.</i> time				(Landing at 120° West longitude off California coast)

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STATION PASS PROCEDURES

<u>Time</u>	<u>Station</u>	<u>Launch</u>
0	MCC	Lift-off
	A	CLOCK OPERATING
	MCC	Roger
T + 30	A	AUTO FUEL _____
		MANUAL FUEL _____
		CABIN PRESSURE _____
		MAIN O ₂ _____
		SECONDARY O ₂ _____
		AMPS _____
		Pitch _____
T + 1:00	A	AUTO FUEL _____
		MANUAL FUEL _____
		CABIN PRESSURE _____
		MAIN O ₂ _____
		SECONDARY O ₂ _____
		AMPS _____
		VIBRATION _____
T + 1:30	A	Pitch _____
		AUTO FUEL _____
		MANUAL FUEL _____
		CABIN PRESSURE HOLDING _____
		MAIN O ₂ _____
		SECONDARY O ₂ _____
		AMPS _____
	MCC	Pitch _____

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Time	Station	Launch
T + 2:00	A	AUTO FUEL _____
		MANUAL FUEL _____
		CABIN PRESSURE _____
		MAIN O ₂ _____
		SECONDARY O ₂ _____
		AMPS _____
	MCC	Pitch _____
T + 2:11	A	REPORT BECO
		ASTRONAUT STATUS _____
	MCC	Pitch _____
T + 2:34	A	REPORT JETT TOWER _____
		REPORT AUTO RETRO JETT - OFF
		RETRO JETT FUSE SWITCH - OFF
	MCC	Pitch _____
T + 3:00	A	AUTO FUEL _____
		MANUAL FUEL _____
		CABIN PRESSURE <i>holding</i>
		MAIN O ₂ _____
		SECONDARY O ₂ _____
		AMPS _____
	MCC	Pitch _____
T + 3:30	A	AUTO FUEL _____
		MANUAL FUEL _____
		CABIN PRESSURE <i>holding</i>
		MAIN O ₂ _____
		SECONDARY O ₂ _____
		AMPS _____
		MAIN BUS VOLTAGE _____

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Time	Station	Launch
T + 3:30 (Cont.)	A	MAIN BATTERY #1 _____ MAIN BATTERY #2 _____ MAIN BATTERY #3 _____ STANDBY BATTERY #1 _____ STANDBY BATTERY #2 _____ ISOLATED BATTERY _____ ASCS VOLTS _____ FANS VOLTS _____ AUTO FUEL _____ MANUAL FUEL _____ CABIN PRESSURE <u>holding</u> MAIN O ₂ _____ SECONDARY O ₂ _____ AMPS _____ Pitch _____
T + 4:00	A	
	MCC	
T + 4:20	MCC	Control Center GO
T + 4:30	A	AUTO FUEL _____ MANUAL FUEL _____ CABIN PRESSURE <u>holding</u> MAIN O ₂ _____ SECONDARY O ₂ _____ AMPS _____ ALL SYSTEMS GO ASTRO GO Trajectory is "good"
	MCC	
T + 5:05	A	SEP CAP GREEN AUX DAMP OK PERISCOPE OUT TURNAROUND STARTED ASCS OK ELECTRICAL SYSTEMS GO

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<u>Time</u>	<u>Station</u>	<u>Launch</u>
T + 5:05 (Cont.)	MCC	Roger. Insertion go. You have a ____ orbit capability.
	A	ROGER - GO
		RETRO DELAY SWITCH TO NORMAL
		LANDING PAG SWITCH - OFF
		EMER RETRO SEQ FUSE SWITCH - OFF
		DROGUE FUSE SWITCH - OFF
		RETRO MANUAL FUSE SWITCH - OFF
		VOX POWER - ON
		ELAPSED TIME ____ MARK

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
MCC HF response at a GET of 1:04:15

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BDA

Launch

PREPASS

Bermuda Flight will monitor events and report those observed to MCC over GSFC loop.

Bermuda CapCom will monitor GSFC in addition to air-to-ground loop so that he will be fully informed on mission status at acquisition; e.g., possibility of abort reported by Cape Retro.

In the event that an abort requiring retro^{SEA} is necessary at BDA, the CapCom will inform the astronaut of the reason for the abort and give a countdown over the A/G loop. Detailed procedures are given in the mission rules.

Appx. GET

Communications

T + 6:00 A: BERMUDA THIS IS MERCURY. OVER.
CC: Roger Mercury. Read you _____.
Confirm orbit _____.
Retro time for 1B is _____. Confirm.
A: RETRO TIME FOR 1B IS _____.
CC: Roger. Retro time for end of first orbit
is _____. Confirm.
A: RETRO TIME FOR END OF FIRST ORBIT IS _____.
CC: Roger. Retro time for end of third orbit is
_____. Confirm.
A: RETRO TIME FOR END OF THIRD ORBIT IS _____.
CC: Roger.
A: ON MY MARK CET WILL BE _____. MARK.
CC: Roger your mark. Your clock is _____ seconds
fast/slow.
A: ROGER.
CC: Going command voice (switches to command voice).
Mercury, this is Bermuda on command voice ...
1-2-3-4-5-4-3-2-1 ... going UHF H1.
A: ROGER. COMMAND VOICE CHECK _____.
(Results of command voice check)
CC: Your V/V_R is _____.

0:08:00 A: Commencing control systems check.

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Appx. GETCommunications

0:09:45 A: Results of control systems check.
0:10:00 Voice contact lost.

Spacecraft Activities

0:05:05 Observation of booster and initial Og sensations.
0:06:15 Check retro ^{Seq.} times with onboard charts.
0:08:00 Control systems check (see reference 4). OR ASMP
AFTER 0:06:15 ACTIVITY.
0:10:00 Astronaut switches to HF on LOS of BDA.

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
BDA HF response at a GET of 1:04:30

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CYI

First Orbit

PASS TIME

Appx. GET

Communications

0:15:00

CC: Contact spacecraft ASAP
Report T/M solid ASAP

A: Confirms contact

CC: Confirms contact

A: Spacecraft Status Report

(See Spacecraft Status Section
reference no. 11)

(Will be done while holding spacecraft
attitude for radar tracking)

CC: Queries from ground to spacecraft

A: Comments to ground

CC: *REPORTS COMPUTER ACCEPTING RADAR DATA*
Spacecraft Activities

0:14:20

Holding 0°, 0°, -34° for radar ~~measurements~~
(on instruments)

0:16:00

From 0:16:00 to 0:20:00 astronaut is observing
coast of Africa. He will report coastal sighting
and other observations. He will give a mark over
the coast with the scope index and record attitudes
at this time. He will mark the onboard tape by
punching the T/M key.

0:16:30

Blood pressure sample (see reference no. 11).

0:21:00

Voice contact lost, astro switches to UHF Lo.

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00

CYI HF response at a GET of 1:04:45

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ATS

First Orbit

No communications contact with the spacecraft is expected during this orbit. However, if communications contact is established, the following procedure will be used:

PREPASS

Control systems check completed (see reference no. 4)
Observations

Appx. GET

Communications

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and
spacecraft activities

Exhaust temp. _____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

0:20:00

UHF Lo check

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
ATS HF response at a GET of 1:05:00

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KNO

First Orbit

PREPASS

Astronaut has been observing Africa and is on UHF Lo. Booster is now directly under spacecraft.

PASS TIME

Appx. GET

Communications

0:21:00

Ccm Tech establishes contact (possible overlap with CYI)

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and yaw maneuver (see spacecraft activities)

Exhaust temp. _____

CC: Queries from ground to spacecraft
Give contingency retrofire time for Area 1C.
ASCS check and dark side checklist to be started at 0:28:00

A: Comments to ground

Spacecraft Activities

0:21:30

Astro switches to UHF Hi (after station report)

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KNO

First Orbit - Concluded

Appx. GET

Spacecraft Activities

0:24:00

The astronaut will perform a yaw maneuver during the brief station report or immediately after. This test is to evaluate the scope for a yaw reference. The astronaut slowly yaws 60° right, then back to 0°. He will read drift off the scope index and attempt to correct for it using the scope as a reference (reference no. 5).

0:28:00

ASCS check and dark side checklist (reference no. 14)
Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
KNO HF response at a GET of 1:05:15

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ZZB

First Orbit

PREPASS

The astronaut has switched to UHF Hi and is probably observing Lake Victoria. ASCS check and dark side checklist.

PASS TIME

Appx. GET

Communications

0:30:00

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact
Report T/M solid ASAP

A: Standard 30-minute report
(See reference no. 11 for complete outline of this report)

CC: Queries from ground to spacecraft
~~Give contingency retrograde time for Area 1C~~
Give retrograde time for Area 1C

A: Comments to ground *Confirm Area 1C retrograde time was received from*
Spacecraft Activities KNO.

Astronaut will report coastal sighting and other observations. He will give a mark over the coast with the scope index and record attitudes at this time. He will mark the onboard tape by punching the T/M key.

0:28:00

The astronaut switches to ASCS to check this system prior to entering the night side of the orbit.

0:37:30

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
ZZB HF response at a GET of 1:05:30

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IOS

First Orbit

PREPASS

The astronaut has checked his ASCS system and is now making observations.

IOS will launch balloon flare approximately 20 minutes prior to closest approach.

PASS TIME

Appx. GET

Communications

0:40:30

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and observations

Exhaust temp. _____

CC: Queries from ground to spacecraft. Give warning 1 minute prior to flare ignition, and give "flare ignition" when sighted from ship.

Line retrosequence times for Orion 1E,
A: Comments to ground F, H. Confirm Area 1D
retrosequence time was received from Z.C.

Spacecraft Activities

0:48:00

The astronaut will report his observations of sunset. Night horizon check. (See reference no. 23)

0:48:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
IOS HF response at a GET of 1:05:45

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MUC

First Orbit

PREPASS

The astronaut has been observing sunset and evaluated the night horizon as a control reference.

PASS TIME

Appx. GET

Communications

0:50:00

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and observations

Exhaust temp. _____

CC: Queries from ground to spacecraft
Give orbital parameter information

0:55:00

~~Give contingency retrofire time for Area 1D~~

Give inverter temp. (2)

A: *Confirm Area 1E, Pond H retrofire*
Comments to ground *times were received from Io 5.*

Spacecraft Activities

0:51:00

The astronaut returns to ASCS and gives reports on his observations. He also reports night observations of cities.

0:57:40

Voice contact lost

Follow normal handover procedures to WOM as soon as WOM establishes contact

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00

MUC HF response at a GET of 1:06:00

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WOM

First Orbit

PREPASS

The astronaut is on FEW and has been reporting his observations to MUC.

PASS TIME

Appx. GET

Communications

0:55:00

Handover from MUC as soon as WOM establishes contact

A: Confirms contact

CC: Confirms contact
Reports T/M solid ASAP

A: Standard 30-minute report (see reference no. 11)

CC: Give CET time check
Queries from ground to spacecraft
~~Give contingency retroblast time for Area 1E~~

Spacecraft Activities

Astronaut makes a standard 30-minute report and is holding attitude for radar tracking

1:02:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
WOM HF response at a GET of 1:06:15

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CTN

First Orbit

PREPASS

Astronaut has just made an all stations HF check and a standard 30-minute report. He is now using the star navigation device.

PASS TIME

Appx. GET

Communications

1:09:00

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and observation

Exhaust temp. _____

CC: Queries from ground to spacecraft

~~Give contingency retro time for Area 1B or Area F~~

Instruct astronaut to prepare for possible reentry

A: Comments to ground

Spacecraft Activities

The astronaut will report his activities with the star navigation device. The astronaut will also eat and will indicate his taste and smell sensations while eating

1:15:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
CTN HF response at a GET of 1:06:30

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HAW

First Orbit

PREPASS

Star tracking and night observation

PASS TIME

Communications

No contact with HAW on the first orbit is anticipated. However, if contact is established the following procedure will be followed:

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status, star tracking, and any other observations

Exhaust temp. _____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

Star tracking, night observations

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
HAW HF response at a GET of 1:06:45

December 21, 1961

GYM

First Orbit

PREPASS

The astronaut has been observing sunrise. He has finished eating and recorded any pertinent information on the onboard tape.

PASS TIME

Appx. GET

Communications

1:27:30

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

Questions on spacecraft and/or astronaut status

Go-No-Go decision for orbit no. 2

A: Spacecraft status ____ (Go except ____ or No-Go)

Astronaut status ____ (Go except ____ or No-Go)

Next orbit ____ (Go or No-Go)

CC: Status for next orbit is ____ (Go or No-Go)

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status and observations

Exhaust temp. ____

CC: Queries from ground to spacecraft

~~Give contingency retrofire time for Area F or~~

~~Area 2A~~ *line retrosequence times for Area 2A, G, and H.*

A: Comments to ground

Spacecraft Activities

The astronaut will be reporting observations to the ground station as the spacecraft passes over the

December 21, 1961

GYM

First Orbit - Concluded

Appx. GET

Spacecraft Activities

U.S. GYM will maintain contact as long as possible
or until MCC makes contact if an overlap occurs.

1:33:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
GYM HF response at a GET of 1:07:00

December 21, 1961

CAL

First Orbit

PREPASS

The astronaut has contact with GYM and is reporting his observations to them.

PASS TIME

Appx. GET

Communications

1:27:00	During the first pass GYM will be in contact with the spacecraft during CAL's contact period. CAL should
to	monitor the spacecraft's transmissions but only initiate
1:31:00	a call to the spacecraft if it is a priority message. If GYM loses voice with the spacecraft for more than 30 seconds CAL should attempt contact. CAL will complete any portion of the GYM transmission that has not been completed.

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
CAL HF response at a GET of 1:07:15

December 21, 1961

TEX

First Orbit

PREPASS

GYM has contact with the spacecraft.. The astronaut is making observations and brief station reports to GYM.

PASS TIME

Appx. GET

Communications

1:30:00

TEX may only have one minute of free contact time between GYM and MCC. If GYM can handoff directly to MCC then TEX should monitor only. If GYM loses contact before MCC can contact the spacecraft TEX should proceed as follows:

1:33:00

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Gives observations and replies to MCC as soon as he receives them

Spacecraft Activities

Observation

1:36:00

Voice contact lost

TEX will handoff to MCC as soon as MCC establishes contact with the spacecraft (appx. 1:33:42)

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:04:00
TEX HF response at a GET of 1:07:30

December 21, 1961

MCC

Second Orbit

PREPASS

The astronaut has been reporting his observations to GYM, CAL, and TEX.

PASS TIME

Appx. GETCommunications

1:33:40

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact
Reports T/M solid ASAPA: Standard 30-minute report (see reference no. 11
for a complete outline of this report)
The blood pressure, exercise, and vision portion
of this report may have been completed before MCC
has contact.

CC: Queries from ground to spacecraft

A: Comments to ground *Line, intersequence times for Aural 2 B and 2 C. Confirm Aural 2 A, B, C. Intersequence times were received from GYM.*
Place red filters over window and scopeSpacecraft Activities

1:39:40

Voice contact lost

Follow the normal handover procedures to BDA after
completion of 30-minute report.All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
MCC HF response at a GET of 1:44:15

December 21, 1961

BDA

Second Orbit

PREPASS

The astronaut has just given a standard 30-minute report to MCC.
The report will carry over into the overlap time.

PASS TIME

Appx. GETCommunications

1:36:15

Handover from MCC

A: Confirms contact

CC: Confirms contact

A: Brief station report (this may be deleted)

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____Secondary O₂ _____

Amps _____

Comments to ground

Exhaust temp. _____

CC: Queries from ground to spacecraft

~~Give contingency retrofire time for Area 2B~~

Give CET time check

*Confirm Orion 2B and 2C retrosequence times**Have received from MCC.*

A: Comments to ground

Spacecraft Activities

1:41:00

Oculogyric test (see reference 16)

1:43:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
BDA HF response at a GET of 1:44:30

December 21, 1961

CYI

Second Orbit

PREPASS

HF radio check

PASS TIME

Appx. GET

Communications

1:48:00

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status and day horizon check
and oculogyric test

Exhaust temp. ____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

1:49:00

Day horizon check (see reference no. 23)

1:51:00

Comments on the coastal crossing and any other
observations

1:53:30

Voice contact lost (Possible handover to ATS)

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
CYI HF response at a GET of 1:44:45

December 21, 1961

ATS

Second Orbit

PREPASS

Day horizon check

PASS TIME

Appx. GET

Communications

1:54:00

Com Tech establishes contact
(Possible handover from CYI)

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status

Exhaust temp. ____

CC: Queries from ground to spacecraft

A: Comments to ground

CC: Handover to KNO

Spacecraft Activities

1:54:00

180° yaw maneuver (Gyros in free position)

1:58:00

Voice contact lost
(Follow normal handoff procedures to KNO prior
to LOS)

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
ATS HF response at a GET of 1:45:00

December 21, 1961

KNO

Second Orbit

PREPASS

Observation - 180° yaw maneuver

PASS TIME

Appx. GET

Communications

1:57:00

Handover from ATS

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status

Exhaust temp. ____

CC: Queries from ground to spacecraft
Start predark side check

A: Comments to ground

Spacecraft Activities

2:01:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
KNO HF response at a GET of 1:45:15

December 21, 1961

ZZB

Second Orbit

PREPASS

Observations - 30-minute report started before initial contact
(see reference no. 11)

PASS TIME

Appx. GET

Communications

2:04:00

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: 30-minute report (see reference no. 11)

Status section may be delayed if vision
section in progress.

Comments on status and observations

Will cross coast of Africa during this period

CC: Queries from ground to spacecraft

~~Give contingency retro time for Area 20~~

A: Comments to ground

Spacecraft Activities

2:08:00

Observations crossing coast of Africa
Passing through sunset

2:10:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
ZZB HF response at a GET of 1:45:30

December 21, 1961

IOS

Second Orbit

PREPASS

Observations - Sunset

IOS will launch two balloon flares approximately 20 minutes prior to closest approach.

PASS TIME

Appx. GET

Communications

2:13:00

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status and sunset observations

Possible observation of flare(s)

Exhaust temp. ____

CC: Queries from ground to spacecraft. Give warning 1 minute prior to flare ignition, and give "flare ignition" when sighted from ship.

Give subsequent tones for power
A: Comments to ground 2 D, 2 E, and G.

Spacecraft Activities

2:17:00

Possible flare observation

Observation of stars and star tracking

2:20:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00

IOS HF response at a GET of 1:45:45

December 21, 1961

MUC

Second Orbit

PREPASS

Observation and star tracking

PASS TIME

Appx. GET

Communications

2:23:00

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status, observation (if any) and star tracking

Exhaust temp. ____

CC: Queries from ground to spacecraft

~~Give orbital parameter information~~

~~Give contingency retrofire time for Area 80~~

Give inverter temps. (2)

Confusion Areas 2D, 2E and 6 retrosequence

A: Comments to ground *Answers were received from LOS.*

Spacecraft Activities

Night observation of cities

2:30:00

Voice contact lost

(Follow normal handover procedure to WOM prior to loss)

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
MUC HF response at a GET of 1:46:00

December 21, 1961

WOM

Second Orbit

PREPASS

Night observation of cities

PASS TIME

Appx. GET

Communications

2:27:00

Handover from MUC

A: Confirms contact

CC: Confirms contact
Reports T/M solid ASAP

2:30:00

A: Standard 30-minute report (see reference
no. 11 for complete outline of report)

CC: Queries from ground to spacecraft
~~Give contingency metro time for Area 2E~~

A: Comments to ground (possible comments on
observation of city lights)

Spacecraft Activities

Night observations

2:35:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
WOM HF response at a GET of 1:46:15

December 21, 1961

CIN

Second Orbit

PREPASS

Star tracking

PASS TIME

Appx. GET

Communications

2:40:00

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manuel fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status, star tracking, and any observations. Comments on eating.

Exhaust temp. ____

CC: Queries from ground to spacecraft

~~Give contingency retroblast time for Area 2E~~

Instruct astronaut to prepare for possible reentry

A: Comments to ground

Spacecraft Activities

2:45:00

Eat

2:49:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
CIN HF response at a GET of 1:46:30

December 21, 1961

HAW

Second Orbit

PREPASS

Eating

PASS TIME

Appx. GET

Communications

2:49:30

Com Tech establishes communication

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and effects of eating

Exhaust temp. _____

CC: Queries from ground to spacecraft

~~Give contingency retrofire time from time G~~

A: Comments to ground

Spacecraft Activities

Observation of sunrise

2:56:00

Voice communications lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
HAW HF response at a GET of 1:46:45

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CAL

Second Orbit

PREPASS

Observations - sunrise

PASSTIME

Appx. GST

Communications

2:58:00

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

Questions on spacecraft and/or astronaut status

Go-No-Go decision for orbit no. 3

A: Spacecraft status ___ (Go except ___ or No-Go)
Astronaut status ___ (Go except ___ or No-Go)
Next orbit ___ (Go or No-Go)

CC: Status for next orbit is ___ (Go or No-Go)

A: Brief station report

Status ___

Auto fuel ___

Manual fuel ___

Main O₂ ___

Secondary O₂ ___

Amps ___

Comments on observations

Exhaust temp. ___

CC: Queries from ground to spacecraft

Line retrosequence times for Orion
A: Comments to ground 3A and 3H.

Note: CAL will have communications control until
fade-cut or contact with MCC at which time
handover will occur.

Spacecraft Activities

Observation of coastal crossing and U.S. landmass

December 21, 1961

CAL

Second Orbit - Concluded

Appx. GET

Spacecraft Activities

3:04:00

Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
CAL HF response at a GET of 1:47:15

December 21, 1961

GYM

Second Orbit

PREPASS

Contact with CAL. Observations - coastal crossing.

PASS TIME

Appx. GET

Communications

3:00:00 During this pass GYM will be in contact with the spacecraft during CAL contact period. GYM will establish to that voice communications exist and then stand by. GYM 3:06:00 will then monitor the spacecraft transmission and only initiate a call to the spacecraft if it has a priority message. If CAL loses voice with the spacecraft for more than 30 seconds, GYM should attempt contact. GYM will complete any portion of the CAL transmission that has not been completed.

Spacecraft Activities

Observation of U.S. landmass

3:06:00 Voice contact lost

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
GYM HF response at a GET of 1:47:00

December 21, 1961

TEX

Second Orbit

PREPASS

CAL has contact with the spacecraft. The astronaut is making observations and brief station reports to CAL.

PASS TIME

Appx. GET

Communications

3:03:00

TEX may only have 45 seconds of free contact time between CAL and MCC. If CAL can handoff directly to MCC, then TEX should monitor only. If CAL loses contact before MCC can contact the spacecraft TEX should proceed as follows:

3:06:00

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Gives observations and replies to MCC as soon as he receives them

Spacecraft Activities

Observations

3:08:00

Voice contact lost

TEX will handoff to MCC as soon as MCC establishes contact with the spacecraft (appx. 3:07:00)

All Stations HF check (see reference no. 12)

1. Spacecraft all stations HF call at a GET of 1:44:00
TEX HF response at a GET of 1:47:30

December 21, 1961

MCC

Third Orbit

PREPASS

Observations - U.S. landmass. Station report to CAL and possible contact with TEX.

PASS TIME

Appx. GET

Communications

3:07:00

Com Tech establishes communications
(MCC communications have priority over all other communications)

A: Confirms contact

CC: Confirms contact
Reports T/M solid ASAP

A: Standard 30-minute report (see reference no. 11 for complete outline)
Part of report (exercise and vision) may have been completed before contact is established

CC: Queries from ground to spacecraft

~~Give contingency retro time for Area 3A~~

Give inverter temperatures (2)

*Give retrosequence times for Areas 3B and 3C.
Comments on Area 3A and H retrosequence times were received from CAL.*
A: Comments to ground (comments on observation while over U.S. landmass)

Spacecraft Activities

3:07:00

Orient spacecraft to orbit attitude and go ASCS.

3:13:00

Voice communication lost

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BDA

Third Orbit

PREPASS

Observation of U.S. landmass (East coast). Standard 30-minute report to MCC.

PASS TIME

Appx. GET

Communications

3:10:00

Com Tech establishes communications
Follow normal handover procedure from MCC

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and observations

Exhaust temp. _____

CC: Queries from ground to spacecraft

~~Give contingency retrofire time for Area 3B~~

A: Comments to ground

Spacecraft Activities

Observations - East coast of U.S.

3:16:30

Voice contact lost

December 21, 1961

CYI

Third Orbit

No communications contact with the spacecraft is expected during this orbit. However, if communications contact is established, the following procedure will be used:

PREPASS

Weather observations

PASS TIME

Communications

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status

Exhaust temp. _____

CC: Queries from ground to spacecraft

Give predark side checklist (see reference no. 14)

A: Comments to ground

Spacecraft Activities

Observations

December 21, 1961

ATS

Third Orbit

PREPASS

Observations of African coast

PASS TIME

Appx. GET

Communications

3:25:30

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: 30-minute report (see reference no. 11)

CC: Queries from ground to spacecraft

~~Give contingency retro time for Area 3B~~

~~and Area 3C~~

Confirm Area 3B and 3C

A: Comments to ground

retro sequence time when received from MCC.

Spacecraft Activities

3:33:30

Voice contact lost

December 21, 1961

KNO

Third Orbit

No communications contact with the spacecraft is expected during this orbit. However, if communications contact is established, the following procedure will be used:

PREPASS

Observations and predark side checklist (see reference no. 14)
30-minute report to ATG.

PASS TIME

Appx. GET

Communications

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments to ground

Exhaust temp. ____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

Observations

December 21, 1961

ZZB

Third Orbit

No communications contact with the spacecraft is expected during this orbit. However, if communications contact is established, the following procedure will be used:

PREPASS

30-minute report to ATS

Observations

PASS TIME

Communications

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status

Exhaust temp. ____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

Observations

December 21, 1961

IOS

Third Orbit

PREPASS

Night observation - sunset, African landmass. Last contact was probably with ATS.

PASS TIME

Appx. GET

Communications

3:47:00

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and sunset

Exhaust temp. _____

CC: Queries from ground to spacecraft
Line significance times for Areas 30, E, and H.

A: Comments to ground

Spacecraft Activities

Observations - night

Possible ship lights observation

3:55:00

Voice contact lost

December 21, 1961

MUC

Third Orbit

PREPASS

Observations

PASS TIME

Appx. GET

Communications

3:56:45

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact
Reports when T/M solid

A: Standard 30-minute report (see reference
no. 11 for complete outline)
Comments on report

CC: Queries from ground to spacecraft
Gives inverter temperatures (2)

Command Voice Check

CC: Going command voice (switches to command
voice) Mercury, this is MUC on command
voice ... 1-2-3-4-5-4-3-2-1 ... going UHF H1

A: ROGER. COMMAND VOICE CHECK (results of
command voice check)
Comments to ground

Spacecraft Activities

Observations

4:03:30

Voice contact lost
Follow normal handover procedure to WOM

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NOM

Third Orbit

PREPASS

Standard 30-minute report to MUC. Observations - night.

PASS TIME

Appx. GET

Communications

4:03:30

Com Tech establishes contact
(follow normal handover procedure from MUC)
(MUC is prime at this time)

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comment on status and observations

Exhaust temp. ____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

Observations

4:05:30

Voice contact lost

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CTN

Third Orbit

No communications contact is expected during this orbit. However, if communications contact is established, the following procedure will be used:

PREPASS

Observation. Preparation for retro ^{Sequence} and reentry.

PASS TIME

Appx. GET

Communications

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status, spacecraft attitude control, and observations

Exhaust temp. ____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

4:18:00

Oculogyric test (see reference no. 16)
Preparation for reentry

December 21, 1961

HAW

Third Orbit

PREPASS

Oculogyric test (see reference no. 16)

Preparation for reentry. Thruster warmup.

PASS TIME

Appx. GET

Communications

4:22:00

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Reentry check list

Comment on observations and preparation for
retro~~fire~~ ^{Sequence} and reentry

Exhaust temp. ____

CC: Queries from ground to spacecraft

Aid with reentry check (see reference no. 7)

Equipment stowage checklist (see reference
no. 6)

Clock check. (CLOCK COUNTS DOWN TO GET 'MARK')

A: Comments to ground

Spacecraft Activities

^{Sequence}
Preparation for retro~~fire~~ and reentry
Observation of sunrise

4:28:00

Voice contact lost

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CAL

Third Orbit

PREPASS

Observation of sunrise. Preparation for retrofire and reentry.

PASS TIME

Appx. GET

Communications

4:31:30

Com Tech establishes communications

A: Confirms contact

CC: Confirms contact

A: Brief station report (if time before retro-sequence allows)

Status _____

Auto fuel _____

Manual fuel _____

Main O₂ _____

Secondary O₂ _____

Amps _____

Comments on status and observations

Exhaust temp. _____

CC: Queries from ground to spacecraft

~~Possible countdown to retrofire and any~~

~~other aid recommended by astronaut~~

~~Countdown to RETROSEQ AND TO RETROSEQ plus~~

~~plus 30 sec.~~

A: Comment to ground

Spacecraft Activities

4:32:50

Retrofire

4:34:00

Exercise and blood pressure test

4:37:30

Voice contact lost

Follow normal handover procedures to GYM

December 21, 1961

GYM

Third Orbit

PREPASS

Retrofire. Reentry attitude.

PASS TIME

Appx. GET

Communications

4:33:30

Com Tech establishes communications
(follow normal handover procedures from CAL)
(CAL is prime at this time)

A: Confirms contact

CC: Confirms contact

A: Brief status report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on retro ^{sequence} and start of reentry

Exhaust temp. ____

CC: Queries from ground to spacecraft

A: Comments to ground

Spacecraft Activities

4:34:00

Reentry
Exercise and blood pressure test

4:39:30

Voice contact lost

Hold communication if possible for handover to
MCC; if not handover to TEX

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TEX
Third Orbit

PREPASS

Reentry

PASS TIME

Appx. GET

Communications

4:37:00

TEX may only have about one minute of free contact between GYM and MCC. If GYM can handover directly to MCC then TEX should monitor only. If GYM loses contact before MCC can contact the spacecraft, TEX should proceed as follows:

4:39:30

Com Tech establishes contact

A: Confirms contact

CC: Confirms contact

A: Gives comments on reentry and replies to MCC as soon as he receives them

Spacecraft Activities

Reentry

4:34:00

Exercise and blood pressure test

4:42:00

Voice contact lost

TEX will handover to MCC as soon as MCC establishes contact with the spacecraft (appx. 4:40:40)

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MCC

Reentry

PREPASS

Reentry

PASS TIME

Appx. GET

4:40:40

Communications

Com Tech establishes communications
Follow normal handover procedure from GYM or TEX
depending upon who has contact at this time

A: Confirms contact

CC: Confirms contact

A: Brief station report

Status ____

Auto fuel ____

Manual fuel ____

Main O₂ ____

Secondary O₂ ____

Amps ____

Comments on status and reentry

Exhaust temp. ____

NOTE: This may be held up to the peak of
portion of the reentry

CC: Queries from ground to spacecraft
Gives spacecraft the following information:

Impact prediction ____

First estimate of recovery time ____
(time elapse from impact to arrival of
helicopter or DD)

Wind velocity ____

Air temp. ____

Wave height ____

December 21, 1961

MCC

Reentry - Concluded

Appx. GET

4:40:40

A: Comments to ground

Spacecraft Activities

Reentry

4:45:24

Voice contact lost

Communications are then coordinated through
down-range stations

December 21, 1961

REFERENCE NO. 1

BECO Checklist

After BECO

1. Jett Tower - GREEN (appx. 20 secs after BECO)
2. Auto Retro Jett switch - OFF
3. Retro Jett Fuse switch - OFF
4. Emer Retro Jett Fuse switch - OFF

December 21, 1961

REFERENCE NO. 2

SECO Checklist

1. Sep Cap - GREEN

2. REPORT

- (a) Aux Damp
- (b) Turnaround
- (c) Periscope out
- (d) ASCS
- (e) Tumbling sensation
- (f) Booster sighting and motions
- (g) Initial Og sensations

(Perform ORBIT CHECKLIST after ORBIT "go" received)

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REFERENCE NO. 3

Orbit Checklist

(Perform after orbit "go" received)

1. Emer Retro Seq fuse switch - OFF
2. Emer Drogue Deploy fuse switch - OFF
3. ~~Land~~ Land Bag switch - OFF
4. Retro Delay switch - NORMAL
5. *Audio warning tone switch* - ON
~~Enter Cabin H₂O F₂O switch~~ - ON
6. Retro Man fuse switch - OFF
7. Jett Tower and Sep Cap telights - OUT (5 min after Sep Cap)

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Control Systems CheckPURPOSE

To check all the control modes in order to assure their readiness as backups to the ASCS system. This procedure will check all control modes. The spacecraft is on ASCS in orbit attitude at the beginning of the test.

PROCEDURE

Record manual and automatic fuel

Manual fuel handle - pull direct

RSCS switch - Rate Comd

ASCS switch - Aux Damp

Pitch up from -34° at $4^{\circ}/\text{sec}$

Manual fuel handle - push Rate Comd

(Observe rate damping to within $\pm 3^{\circ}/\text{sec}$)

RSCS switch - Auto

(Observe aux. damping to within $\pm 0.5^{\circ}/\text{sec}$)

ASCS switch - FBW

(Zero rate at 0° pitch)

ASCS switch - Aux Damp

RSCS switch - Rate Comd

Manual fuel handle - pull direct

Initiate $4^{\circ}/\text{sec}$ yaw right

Manual fuel handle - push Rate Comd

(Check rate damping to within $\pm 3^{\circ}/\text{sec}$)

RSCS switch - Auto

(Check aux. damping to within $\pm 0.5^{\circ}/\text{sec}$)

ASCS switch - FBW

(Zero rate at 30° yaw right)

Reset ASCS and RSCS switches and pull manual fuel handle

Initiate $4^{\circ}/\text{sec}$ yaw left

Manual fuel handle - push Rate Comd

(Observe rate damping to within $\pm 3^{\circ}/\text{sec}$)

RSCS switch - Auto

(Observe aux. damping to within $\pm 0.5^{\circ}/\text{sec}$)

ASCS switch - FBW

(Zero rate at 0° yaw)

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REFERENCE NO. 4 - Concluded

Control Systems Check

Reset ASCS and RSCS switches and pull manual fuel handle

Initiate 4° /sec roll right
Manual fuel handle - push Rate Comd
(Observe rate damping to within $\pm 3^{\circ}$ /sec)
RSCS switch - Auto
(Observe aux. damping to within $\pm 0.5^{\circ}$ /sec)
ASCS switch - FBW
(Zero rate at 30° roll right)

Reset ASCS and RSCS switches and pull manual fuel handle

Initiate 4° /sec roll left
Manual fuel handle - push Rate Comd
(Observe rate damping to within $\pm 3^{\circ}$ /sec)
RSCS switch - Auto
(Observe aux. damping to within $\pm 0.5^{\circ}$ /sec)
ASCS switch - FBW
(Zero rate at 0° roll)

Use high thrust jets on FBW as needed or check them at this point

Reset ASCS and RSCS switches and pull manual fuel handle

Initiate 4° /sec pitch down
Manual fuel handle - push Rate Comd
(Observe rate damping to within $\pm 3^{\circ}$ /sec)
RSCS switch - Auto
(Observe aux. damping to within $\pm 0.5^{\circ}$ /sec)
ASCS switch - FBW
(Zero rates at 0° yaw, 0° roll, -34° pitch)

Record manual and automatic fuel

Estimated fuel usage: 5% auto
5% manual

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REFERENCE NO. 5

Yaw Maneuver Check

PURPOSE

The yaw maneuver will be used to check the periscope as a yaw reference when large angular errors exist.

PROCEDURE

1. Switch to fly-by-wire control system (if necessary)
2. Set up low yaw right (1° to 2° /sec) rate.
3. Allow the spacecraft to drift until the yaw angle becomes approximately 60° .
4. Stabilize the spacecraft rates to zero.
5. Observe the motion of the ground track through the periscope on both low and high magnification.
6. Set up a low left yaw motion and stabilize the spacecraft attitude at 0° yaw, 0° roll, and -34° pitch. Use periscope as the reference.
7. Record results of the maneuver.

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Equipment Stowage Checklist

1. ~~Stow~~ in container if not already secured:

- (a) Microfilm viewer
- (b) Cameras
- (c) Light meter
- (d) Visual test device
- (e) Glasses (viewing)
- (f) Spectrometer
- (g) Extra film
- (h) Pliers

- (a) Camera
- (b) Light meter - Visual test device - Spectrometer
- (c) Unexposed film
- (d) Star navigation device
- (e) food

~~2. Tie down exercise device handle~~

3. Stow maps in map case

4. Stow flashlight and knife in holders

5. Stow securely in suit or have accessible:

- (a) Scissors
- (b) Four-six injectors
- (c) Watch
- (d) Pocket knife

6. Store in waterproof bag

- (a) microfilm viewers
- (b) glasses
- (c) exposed film
- (d) pliers

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REFERENCE NO. 7

^{Seq.}
Preretro ~~Seq.~~ Checklist

1. Equipment - STOWED
2. Control System - CHECK (thruster warmup)
3. Emer Retro Seq fuse switch - NO. 1
4. Transmit switch - UHF
5. Retro Man fuse switch - NO. 1
6. Restraint Devices - CHECK
7. Crosscheck Attitude - Window/Instruments/Scope
8. Time check CET

*NOTE: If flight continues return item 3 to
"OFF" and return item 5 to "OFF".*

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REFERENCE NO. 8

Post-Retro ^{Sequence} Checklist

1. Auto Retro Jett - ARM
2. Emer Retro Jett Fuse switch - NO. 1
3. Retro Jett Fuse switch - NO. 1
4. $T_R + 60$ sec Jett Retro Telelight - GREEN
5. Crosscheck Attitude - Window/Instruments/Scope
6. Periscope - RETRACTED - 30 sec. after RETROJETT
7. 0.05g Telelight - GREEN - $T_R + 645$ sec.
8. Rate Indicator - 10^0 /sec Roll

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REFERENCE NO. 9

Post-Entry Checklist

(Accomplished after peak g)

1. Emer Drogue Deploy fuse switch - NO. 1
8. ~~2.~~ Landing Bag switch - ~~NO.~~ *Auto*
2. ~~3.~~ At 21,000 feet, drogue deployed
4. Periscope - EXTEND
5. At 17,000 feet, snorkel ring - FULL
6. Emer O₂ handle - EMER
8. ~~7.~~ At 10,000 feet, main telelight - GREEN (check main deployment visually)
9. ~~8.~~ Astronaut preparation for landing
 - (a) Disconnect Biomed cable
 - (b) Disconnect Blood Pressure Cuff hose
 - (c) Disconnect Chest Strap
 - (d) Disconnect Visor Seal hose
 - (e) Open Visor
 - (f) Disconnect Respiration Sensor
 - (g) Disconnect Helmet Exhaust hose
 - (h) Unstow Survival Kit
10. ~~9.~~ Landing Bag telelight - GREEN
3. ~~10.~~ Fuel handles - CHECK/IN
11. Press Reg handle - PULL AND TURN
12. UHF/DF switch - R/T
12. ~~12.~~ *VOX POWER-OFF.*
13. Fuel dump, check Auto-Man Fuel Gage - 0/0

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REFERENCE NO. 9(a)

Postlanding Checklist

1. Rescue Aids - MAN
2. Release Restraining Harness
3. Disconnect Helmet
4. Install Neck Dam
4a. Store flashlight in pocket on survival kit.
5. When ready to egress:
 - (a) Disconnect Suit Inlet hose
 - (b) Disconnect Communication lead
 - (c) Ammeter - OFF
6. Egress with Survival Kit *and waterproof equipment bag.*

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REFERENCE NO. 10

C W Code

I. Action or Information

AAA	I concur
AR	End of message
BT	Message follows
DA	D-C Amps
EEEE	Error
EF	Emergency O ₂ rate flow
F	Off
GR	Rate gyros
HA	Holding proper attitude
HFR	HF receiver
HFT	HF transmitter
J	Left
K	Center
L	Leaking
MAN	Operated manually
N	No, negative
O	On
OK 1,2,3	Status green for 1,2,3 orbits
Q	Request, question
R 1,2,3	End of 1,2,3 orbit retrofire time
RS	Retrosequence
REO	Reentering at end of this orbit
REP	Repeat last transmission
RRR	Roger
T	Temperature
UUUU	Aborting or reentering immediately

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REFERENCE NO. 10 - Continued

C W Code

I. Action or Information - Concluded

VVVV	Reentering next contingency
W	Right
X	Out of operation
Y	Yes, affirmative
Mark	Long dash with Mark at end of dash

II. Primary Instruments and Switches

(Left-to-right across panel)

SQ	Squib Switch
MC	Manual Control
AS	ASCS Normal
AD	Aux Damp
FB	Fly-By-Wire
RA	RCS AUTO
RC	Rate Comd
GN	Gyros Normal
GF	Gyros Free
GC	Gyros Cage
A	Auto Control Fuel
M	Man Control Fuel
GMT	Clock - GMT
CET	Capsule Elapsed Time
CRT	Capsule Retrograde Time
TTR	Time to Retrograde
CP	Cabin Pressure
ST	Suit Temperature
OP	Oxygen - Primary
OS	Oxygen - Secondary
DV 1,2,3,S1,S2,I,M	D-C Volts 1,2,3, Sby 1, Sby 2, Isol, Main
DA	D-C Amps
AVA	A-C Volts ASCS
AVF	A-C Volts Fans

REFERENCE NO. 10 - Continued

C W Code

II. Primary Instruments and Switches - Concluded

IF	Fans Inverter
IA	ASCS Inverter
IS	Standby Inverter
UH R,T	UHF Hi Receiver, Transmitter
UL R,T	UHF Low Receiver, Transmitter

III. Systems (Secondary Instruments and Switches)

A. Fuse Panel

F 1	Emerg. Cap. Sep. Control
F 2	Emerg. Escape Rocket
F 3	Tower Sep. Control
F 4	Emerg. Tower Sep
F 5	Emerg. Tower Jett
F 6	Emerg. Posigrade
F 7	Aux. Bcn.
F 8	Retrorocket no. 1
F 9	Retrorocket no. 2
F 10	Retrorocket no. 3
F 11	Emerg. Retro Seq
F 12	Emerg. Retro Jett
F 13	ASCS 0.05g
F 14	Emerg. 0.05g
F 15	Emerg. Drogue Deploy
F 16	Emerg. Main Deploy
F 17	Reserve Deploy
F 18	Emerg. Reserve Deploy
F 19	Emerg. Land. Bag
F 20	Emerg. Rescue Aids
F 21	Periscope
F 22	Ant. Switch

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REFERENCE NO. 10 - Continued

C W Code

A. Fuse Panel - Concluded

F 23	Cml. Rec. A
F 24	TIM HI freq

B. Left Panel

L 1	Auto Retro Jett
L 2	Manual Fuel T-handle
L 3	ASCS Roll Fuel T-handle
L 4	ASCS Yaw Fuel T-handle
L 5	ASCS Pitch Fuel T-handle
L 6	Decom T-handle
L 7	Repress T-handle
L 8	Retro Delay
L 9	Photo Lights
L 10	Cabin Lights
L 11	TIM Lo freq
L 12	Rescue Aids

C. Sequence Panel

S 1	Abort Light
S 2	Launch Control
S 3	Cabin press regul. lock
S 4	Jett Tower
S 5	Sep. Capsule
S 6	Retro Seq
S 7	Retro Att
S 8	Fire Retro
S 9	Jett Retro
S 10	Retract Scope
S 11	0.05g
S 12	Drogue
S 13	Snorkel

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REFERENCE NO. 10 - Continued

C W Code

C. Sequence Panel - Concluded

S 14	Main
S 15	Reserve
S 16	Landing Bag

D. Center Panel

C 1	Accelerometer
C 2	Descent
C 3	Altimeter
C 4	Light Test
C 5	Rate Ind. Switch
C 6	Roll Attitude (C6R Roll Rate)
C 7	Yaw Attitude (C7R Yaw Rate)
C 8	Pitch Attitude (C8R Pitch Rate)
C 9	EPI
C 10	Periscope

E. Right Panel

R 1	Cabin Air Temperature
R 2	Cabin Relative Humidity
R 3	Coolant Quantity
R 4	Suit Pressure
R 5	O ₂ Flow Switch
R 6	Suit Fan Switch
R 7	Cabin Fan Switch
R 8	ASCS A-C Bus Switch
R 9	Ammeter Switch
R 10	Inlet Valve Power Switch
R 11	Standby Battery Switch
R 12	Isolated Battery Switch
R 13	Standby A-C Auto Indicator Light
R 14	Audio Bus Switch

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REFERENCE NO. 10 - Concluded

C W Code

E. Right Panel - Concluded

R 15	Fans A-C Bus Switch
R 16	Audio Panel
R 17	UHF DF Switch
R 18	UHF Select Switch
R 19	Transmit Switch
R 20	Beacon Switch
R 21	Vox Power Switch
R 22	Blood Pressure
R 23	SUIT HEAT EXCHANGER Exhaust TEMPERATURE

F. Right Panel Warning Lights

RW 1	Cabin Pressure
RW 2	O ₂ Quantity
RW 3	O ₂ Emergency
RW 4	Excess Suit H ₂ O
RW 5	Excess Cabin H ₂ O
RW 6	Fuel Quantity
RW 7	Retro Warning
RW 8	Retro Reset

G. Right Panel Fuse Switches

RF 1	Suit Fan
RF 2	Environmental Control
RF 3	Retro Jett
RF 4	Retro Manually
RF 5	Programmer
RF 6	Blood Pressure

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30-Minute Report

To determine at regular intervals the complete status of the astronaut and the spacecraft.

T + 0 Push blood pressure switch - start
 Take one blood pressure sample
 Push blood pressure switch - stop

T + 1 min Exercise - 30 pulls on Bungee cord

T + 2 min Push blood pressure switch - start
 Take one blood pressure sample
 Push blood pressure switch - stop

T + 3 min Visual acuity test

Snellen test
Astigmatic test

Head motions - pitch, roll, yaw
Reach accuracy
Line position check
Spacecraft status report

Fuse panel - only report abnormal fuse switch positions

Squib switch _____
Auto Retro Jett switch _____
Control system mode _____

ASCS switch _____
 RSCS switch _____
 Gyro switch _____
 Manual fuel handle _____
 Automatic fuel handles _____
 Retro delay _____

Sequence panel - only report abnormal settings or indications

Auto fuel

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REFERENCE NO. 11 - Concluded

30-Minute Report

Manual fuel _____
 Attitude: Roll _____ Yaw _____ Pitch _____
 Periscope and window agreement. Note any filters
 being used. (If attitude is normal this portion
 of the report may be deleted)
 Earth-Path Indicator position _____
 (Retrospective) time _____
 Capsule elapsed time _____
 Cabin pressure _____
 Cabin temperature _____
 Relative humidity _____
 Coolant quantity _____
 Suit temperature _____
 Suit pressure _____
 Exhaust temperature _____
 Main O₂ _____
 Secondary O₂ _____
 D-C volts _____

Main _____
 1 _____
 2 _____
 3 _____
 Standby 1 _____
 Standby 2 _____
 Isolated _____

D-C amps _____
 A-C volts _____

ASCS _____
 Fans _____

All switches outboard except _____ (see FCH-1 Main
 Instrument Panel)

Comfort control settings _____

Suit temp _____
 Cabin temp _____

Queries from ground to spacecraft _____

Astronaut comments _____

Any spacecraft malfunctions take precedence and will be
 reported first along with corrective action taken

TOTAL TIME: 6 1/2 minutes

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REFERENCE NO. 12

All Stations HF Check

PURPOSE

To check the HF range of the spacecraft and ground stations under varying conditions.

PROCEDURE

For time of each action see following chart.

1. Spacecraft initiates a HF call to all ground stations lasting for 15 seconds.
2. The ground stations call sequentially along the ground track, starting with MCC, at the time down below, whether the spacecraft transmission has been received or not.
3. The ground reports start each 15 seconds with each call lasting 10 seconds.
4. The spacecraft will not answer any of the replies, but will record what is received on the tape.
5. Stations will not transmit until the previous stations have completed their call, if the previous station can be heard.
6. All transmission times, including the spacecraft's, are based on GET.

COMMUNICATIONS FORMAT

Spacecraft: ALL MERCURY NET STATIONS, THIS IS ____* (repeat). Over

Station: ____* THIS IS ____**. GMT IS _____. READ YOU _____
(repeat). Out

*Write in spacecraft call sign

**Write in site call sign

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REFERENCE NO. 12 - Continued

All Stations HF Check

Check no.	1	2	
Orbit no.	1	2	
Approximate Spacecraft Position	IOS	CXI	STATION
Start Transmission Time (GET)	1:04:00	1:44:00	Spacecraft
	1:04:15	1:44:15	Mercury Con. Cen.
	1:04:30	1:44:30	Bermuda
	1:04:45	1:44:45	Grand Canary
	1:05:00	1:45:00	Atlantic Ship
	1:05:15	1:45:15	Kano
	1:05:30	1:45:30	Zanzibar
	1:05:45	1:45:45	Indian Ocean Ship
	1:06:00	1:46:00	Muchea
	1:06:15	1:46:15	Woomera
	1:06:30	1:46:30	Canton Island
	1:06:45	1:46:45	Hawaii
	1:07:00	1:47:00	Guaymas
	1:07:15	1:47:15	California
	1:07:30	1:47:30	South Texas

TOTAL TIME: 3 minutes 45 seconds

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REFERENCE NO. 12 - Concluded

All Stations HF Check

PURPOSE

To check the HF range of the spacecraft at sunrise and sunset.

PROCEDURE

The astronaut will call all Mercury net stations at orbit sunrise and orbit sunset, giving GMT at least a 15-second description of the sunset or sunrise. The Mercury net stations will not answer this transmission.

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REFERENCE NO. 13

Contact Procedures

A. NORMAL

1. At H-2 (2 min prior to the spacecraft coming over the horizon) Com Tech initiates a call to the spacecraft every 30 sec; i.e.,
"_____ THIS IS _____ COM TECH. OVER"
2. When the spacecraft receives this call he will reply
"_____ THIS IS _____. READ YOU _____. OVER"
3. The station CapCom confirms contact with the spacecraft.

B. HANDOVER

1. The station CapCom will monitor the spacecraft's transmissions to the preceding ground station. The CapCom should call the spacecraft without blocking out either the spacecraft or preceding ground station; i.e.,
"_____ THIS IS _____. READ YOU _____. OVER"
2. The astronaut, upon hearing the above transmission, will reply either:
 - (a) "ROGER, _____ CAPCOM. STANDBY"
 - (b) "ROGER _____. READ YOU _____. OVER"
3. If the astronaut responds as in example (a), the CapCom will wait for a call from the spacecraft.

If he responds as in example (b), the CapCom confirms contact.

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REFERENCE NO. 14

Predark Side Checklist

1. Check flashlight readily accessible
2. Position Cabin Light switch to BOTH
3. Photo lights - off
4. Place RED filters over cabin lights
5. Place filters over window and scope as required
6. Warning lights - dim
7. Thruster warmup procedure
 - (a) Go to MP mode (warmup for manual thrusters)
Pitch UP followed by pitch DOWN
Roll RIGHT followed by roll LEFT
Yaw RIGHT followed by yaw LEFT
 - (b) Go to FBW mode (warmup for Hi and Lo thrusters)
Short-burst pitch UP and DOWN - full stick travel
Short-burst roll RIGHT and LEFT - full stick travel
Short-burst yaw RIGHT and LEFT - full stick travel
 - (c) Go to ASCS mode and check for proper attitude
Orientation and holding within limits
8. Eye patch in place
9. After entry into dark side, filters on window and scope - as desired
10. Remove red filters from windows and scope as preferred.

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REFERENCE NO. 16

Oculogyric Test Procedure

PURPOSE

To determine the vestibular effects of weightlessness.

PROCEDURE

1. Announce test for tape recorder.
2. Switch to FBW control mode.
3. Observe cross made by rate needles on rate and attitude indicator.
4. Apply left roll command of $2^{\circ}/\text{sec}$ using low thrust FBW for 4 seconds.
5. Observe movement of cross and give mark when motion stops.
6. Apply right roll command of $2^{\circ}/\text{sec}$ using the low thrust FBW for 4 seconds.
7. Observe movement of cross and give mark when motion stops.
8. Apply right roll command of $2^{\circ}/\text{sec}$ using the low thrust FBW for 4 seconds.
9. Observe movement of cross and give mark when motion stops.
10. Apply left roll command of $2^{\circ}/\text{sec}$ using low thrust FBW for 4 seconds.
11. Observe movement of the cross and give mark when motion stops.
12. Damp all residual rates to zero, and reorientate spacecraft to orbit attitude.

- NOTE: (a) The ground station should continuously monitor attitude during this maneuver.
- (b) If the roll attitude exceeds $\pm 45^{\circ}$ the ground is to communicate this to the spacecraft and also report each 2° over $\pm 45^{\circ}$.

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REFERENCE NO. 18

Star Tracking and Star Navigation Device Procedure

1. Star Tracking. From orbit attitude, the spacecraft will be pitched up to approximately 34° . A star will be chosen which falls on the approximate center line of the window. The spacecraft will then be pitched down at a rate to hold the star in the same position relative to the window. The procedure is complete when the astronaut is satisfied with his ability to hold a star in a fixed position with respect to the spacecraft window.

2. Star Navigation Device. This device may be used to determine what stars are visible when spacecraft position (from elapsed time) and attitude are known. It has a dual sliding scale for setting in CET and degrees of pitch. A window on the scale then shows the stars which will be visible through the spacecraft window. A series of star chart inserts are provided to approximately correspond to launch time.

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Celestial Observations

PURPOSE

To observe celestial phenomena not observable from the earth's surface because of the atmosphere.

SCOPE

Emphasis should be on observing hazy, dim, poorly-defined light and/or objects which may appear. Bright, well-known stars and planets are not of prime interest.

METHOD

1. Visual observation with the naked eye will be the primary mode of observation. The use of binoculars is not required.
2. The most desirable means of recording observations will be by sketches and notes. If this is not possible in flight, they may be prepared on the ground following the flight.
3. Locations of observed phenomena may be given relative to known stars and planets, geographic position of the astronaut and bearing, or time of the object's rising or setting and bearing.
4. Spectrographic photography of stars and planets will be attempted, if the special camera is available.
5. A green pass filter will be provided for viewing aurora and night air glow.

OBSERVABLE PHENOMENA

1. Sun's Outer Corona. This is the most readily observable and predictable phenomena. For this observation the astronaut must be dark-adapted and therefore is limited to making the observation just prior to sunrise. It is not observable when the sun has risen. Caution must be exercised to avoid looking at the sun proper when it rises, inasmuch as the corona is only 1 or 2 sun's radii distant from the sun. Equatorial streamers, oriented in the sun's magnetic field approximately 30° to the ecliptic, may be observed.
2. Star Count. A count of the number of stars visible in a known constellation, such as the bowl of the Big Dipper, Pleiades, or the belt December 21, 1961

Celestial Observations

of Orion, is highly desirable as a means of determining the lowest magnitude stars visible to the naked eye outside of the atmosphere.

3. Zodiacal Light. This is a faint glow from illuminated dust of comets and meteors observable further out from the Sun's Outer Corona, and may be observed concurrently with the Outer Corona, in the ecliptic. It is brightest at the horizon and dims to the Gegenshein, 180° from the sun.

4. Gegenshein. The Gegenshein, or counter-glow, is a dim $8^\circ \times 5^\circ$ elliptical light in the ecliptic, 180° from the sun. Its existence is known, but its relation to the earth and/or sun has not been determined. Any observation would be desirable, but the most information would be gained by observing from points of maximum separation on the earth to determine the presence or absence of a parallax shift relative to the stars. The shift would be small, if present, on the order of $3''$, from points 180° apart on the earth's surface.

5. Libration Clouds. Verification of the existence or non-existence of the Libration Clouds (or Points) is highly desirable, but probably a difficult task. These clouds were reported by a Polish astronomer to be 5° wide, and are located 60° ahead and 60° behind the moon in the ecliptic. They are extremely faint, if they exist at all, as seen from the earth and are thought by some to be clouds of lunar material.

6. Comets. Comets, old or new, may be observed. They should be easily identifiable. If seen, note size, brightness, location, proportion of head to tail, number of tails, and orientation of tail(s). They will probably appear at sunrise inside the earth's orbit.

7. Night Air Glow. Air glow may be observable in the atmosphere. Use the green pass filter. Check for orientation with the earth's magnetic field.

8. Aurora. Aurora may be observed. Use the green pass filter. Check for orientation with the earth's magnetic field.

9. Noctilucent Clouds. These may be observed below the astronaut, at an altitude of approximately 43 miles.

10. Nacreous Clouds. These may be clouds of ionized gases, and may appear at an altitude of approximately 100 miles.

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REFERENCE NO. 19 - Concluded

Celestial Observations

11. Star Occultations. Star occultations by the atmosphere will occur. The degree of occultation is of interest, but it is doubtful whether this can be observed with the naked eye to a finer precision than already determined by other means.

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REFERENCE NO. 20

Weather Notes

1. First Orbit - 0:05:00 to 0:18:00

North Atlantic - storms and cyclonic disturbances north of the ground track. Possible frontal pattern. Note size, shape, and cloud height within a given pattern.

2. First Orbit - 0:15:00 to 0:18:00

Possibility of cellular cloud patterns off the west coast of Africa.

3. First Orbit - 0:18:00 to 0:30:00

Good weather to north of track. A possibility of blowing sand in the desert. Note direction and location of the moving sand. High possibility of cloud cover to the south of the track (the inter-tropical convergence zone).

4. First Orbit - 0:34:00

Indian Ocean - subtropical high. A possibility of cellular pattern in this area.

5. First Orbit - 0:40:00 to 1:05:00 (night)

Note any cloud patterns visible by night illumination (moon and/or stars). Check for any lightning activity (East Australia), note frequency of flashes and general size of disturbance. Possible correlation of light level with known light source.

6. First Orbit - 1:05:00 to sunrise

Inter-tropical convergence zone. Note any cloud illumination and lightning visible. See note (e). (The ITC zone should be south of the equator around January.) The ITC zone might be separated into two parts in this area.

7. First Orbit - 1:20:00 to 1:30:00

Possibility of cellular cloud patterns.

8. First Orbit - approximately 1:30:00

Over Mexico - note difference between clouds and snow if possible.

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REFERENCE NO. 20 - Continued

Weather Notes

9. First Orbit - approximately 1:36:00

Crossing intersection point of first and second orbits. Picture of a particular cloud group. Note time and direction of area photographed. (This photograph to be repeated at the end of the second orbit.)

10. Second Orbit - 1:37:00 to 1:50:00

North Atlantic - See note (a).

11. Second Orbit - approximately 2:00:00

Crossing equator. Note inter-tropical convergence zone. Note cloud types, size and particularly cloud heights. Possibility of fog off east coast around Gabon.

12. Second Orbit - 2:50:00 to 3:00:00

Possibility of cloud "streets." Note altitude of clouds and directions. Are all the clouds in a given group at about one altitude or are they spread over a wide range of altitudes? The direction of the cloud "streets" will indicate the direction of the prevailing winds.

13. Second Orbit - approximately 3:09:00

Intersection with first orbit ground track. See note (1).

14. Third Orbit - 3:20:00 to 3:30:00

Inter-tropical convergence over the ocean. Note any cloud "streets" that may exist north and south of the ITC zone. Check the orientation as they can be seen.

15. Third Orbit - approximately 3:34:00

Check for fog and/or low stratus off western coast of Africa.

16. Third Orbit - approximately 3:34:00

Cold ocean current going north along the coast.

NOTE: (a) Many of the possible observations given for one orbit will apply to each orbit.

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REFERENCE NO. 20 - Concluded

Weather Notes

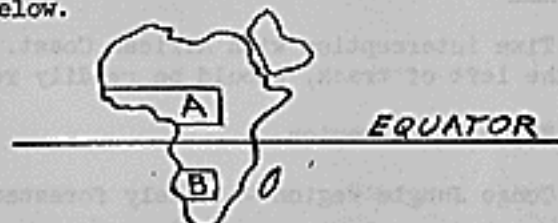
- (b) When noting cloud patterns the points of interest are what types of clouds (by name if possible) make up the patterns and at what height does each type of cloud occur.
- (c) Details of cellular patterns (convective cells):
- (1) Average 30 to 40 miles across (from 10 miles to 90 miles)
 - (2) Thought to be confined between two air layers with the top about 6,000 to 8,000 feet.
- (d) Dust layers - If these are visible, they will be seen near the horizon in an edge view.

December 21, 1961

Landmark Observation Comments

First Orbit

1. Canary Islands plus African Coast should be easily recognizable since Canaries are volcanic in origin and rise abruptly from the ocean. However, cold Canary current flowing toward Equator past islands causes considerable fog and low clouds along coast, especially during N. hemisphere winter. Inland in Africa a few miles there should be few clouds unless a major meteorological occurrence interferes; e.g., a low pressure center over W. Mediterranean causing west winds in this area.
2. Anti-Atlas Range of the Atlas Mountains should be visible.
3. Ahaggar Mountains at 0:23:00 should be visible to left of track. Lava outflows from center peaks contrast favorably with lighter colored surrounding sands and gravels.
4. Lake Chad will probably be at an intermediate level during December - January. This is a shallow, greatly fluctuating shoreline lake. Saline deposits around lake may be more visible than lake itself. However, marsh-type vegetation should provide contrast where water has recently been present.
5. A brief description of areas A and B as shown in this sketch of Africa is delineated below.



- Area A: Tropical Savanna region in N. hemisphere. Very wet in March - September. Dessicated and dry from September to March, especially so in December and January.
- Area B: Exactly opposite to Area A. Wet in December and January. Should be very green, contrasted to dry and yellow in Area A.

6. Lake Victoria and Lake Albert - excellent checkpoints. Check number of snow-capped peaks in area and attempt to identify.

December 21, 1961

REFERENCE NO. 21 - Continued

Landmark Observation Comments

7. Perth region should be dry this part of the year (January - February). City should be visible, but at night lights may not be visible even though city and suburbs have over 200,000 people. Suggest having air fields in vicinity turn on high-intensity landing runway lights if available.

8. Lights also at Brisbane.

9. See if Rio Grande River is visible in U.S.

10. What type of earth landscapes are visible, i.e.:

(a) Agricultural - can you see cultivated vs. pastures, etc., by checkerboard pattern?

(b) Are major highways and railroads visible?

(c) Are large cities visible?

(d) Can you see large bridges across Mississippi River?

(e) Are woods and forests a darker color so that they are readily discernible?

Second Orbit

1. Time interception with African Coast. Cape Blanc, the hook just to the left of track, should be readily recognizable.

2. Niger Delta region.

3. Congo Jungle region - densely forested.

4. Madagascar - excellent checkpoint. Does east side look different from west side? How does it look different?

5. Are waters of Colorado River visible where they flow out into upper Gulf of California?

6. There are some good black and white high-altitude rocket shots of El Paso area at same altitude as spacecraft. This should provide a perfect 1 to 1 comparison to check if this is what astronaut saw and if color provides him with any additional information.

December 21, 1961

REFERENCE NO. 21 - Concluded

Landmark Observation Comments

7. Check cloud cover along coast to see effect of ocean currents on weather. Maybe astronaut could determine various limits of currents by color and outline them on MOC chart.

Third Orbit

1. Across Kalahari Desert in S. Africa. Land should get greener as spacecraft proceeds from West to East. Okovango Basin should be visible but no water should be in Lake Ngami.

December 21, 1961

REFERENCE NO. 22

Onboard Equipment List

1. Microfilm Viewer
2. Exercise Device
3. Food
 - (a) 2 tubes
 - (b) 1 candy bar
4. Water (appx. 1,000 cc)
5. Two 35 mm Cameras
 - (a) One for color photography
 - (b) One for ultra-violet photography
6. Light Meter; *Visual test device; Spectrometer, Color, and*
- ~~7. Visual Test Device~~ *Brightness Tester.*
8. Container
9. Glasses (viewing)
10. Wire Antenna *(in survival kit)*
- ~~11. Spectrometer, Color, and Brightness Tester~~
12. Extra Length of Hose
13. Maps
- ~~14. Window Filter~~
15. Extra Film
16. Tape for Lights
17. Knee Pad and Paper
18. Spare Bulbs
19. Elbow and Helmet Pads
20. Flashlight *with red filter.*
21. Scissors
22. Four-six Injectors
23. Vest and Mirror
24. Two Arm Mirrors
25. Watch
26. Knife
27. Pocket Knife
28. Pliers
29. *Waterproof equipment bag.*

December 21, 1961

REFERENCE NO. 23

Day and Night Horizon Check

PURPOSE

To determine the ability of the astronaut to control the attitude of the spacecraft using the horizon as a control reference under day and night conditions.

PROCEDURE

1. Switch to manual proportional control
2. Aline the spacecraft to orbit attitude on the instruments
3. Pitch up to -14° (window reference)
4. Return pitch to orbit (window reference)
5. Roll right 20° (window reference)
6. Return to orbit attitude (window reference)
7. Yaw left 20° (window reference)
8. Return to orbit attitude (window reference)

NOTE: Very low spacecraft rates will be used at all times.

December 21, 1961

JAN 11 1962

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
January 9, 1962

MEMORANDUM for All Concerned

Subject: Revision A to Flight Plan for Mercury-Atlas Mission 6

1. Enclosed herewith is one copy of the Revision A to the Flight Plan for Mercury-Atlas Mission 6 dated December 21, 1961.

2. This revision consists of pen and ink corrections to the Flight Plan and two pages of instrument panel illustrations to be used with Reference No. 10 (C W Code).

Helmut A. Kuehn
Helmut A. Kuehn
Head, Flight Activities Section
Spacecraft Operations Branch

Enc:

1. Revision A
2. Illustrations

HAK:bsk

HJ

FLIGHT PLAN FOR MERCURY-ATLAS MISSION 6

Revisions

1. Replace the word "retrofire" with "retrosequence" where appearing throughout.
2. All retrosequence times should be considered incorrect. See MA-6-13 Mission Rules for correct retrosequence times.
3. All Acquisition and LOS times should be considered approximate. See MA-6-13 Mission Rules for exact times.
4. Revise Flight Plan Mission Rule 5 to read:

"When the spacecraft is on FSW or manual proportional control the spacecraft attitudes will be kept within the following limits:

<u>Pitch</u>	<u>Yaw</u>	<u>Roll</u>
+60°, -64°	±60°	0°
0°	0°	±60°

The yaw turnaround during the second orbit will be an exception to this rule."

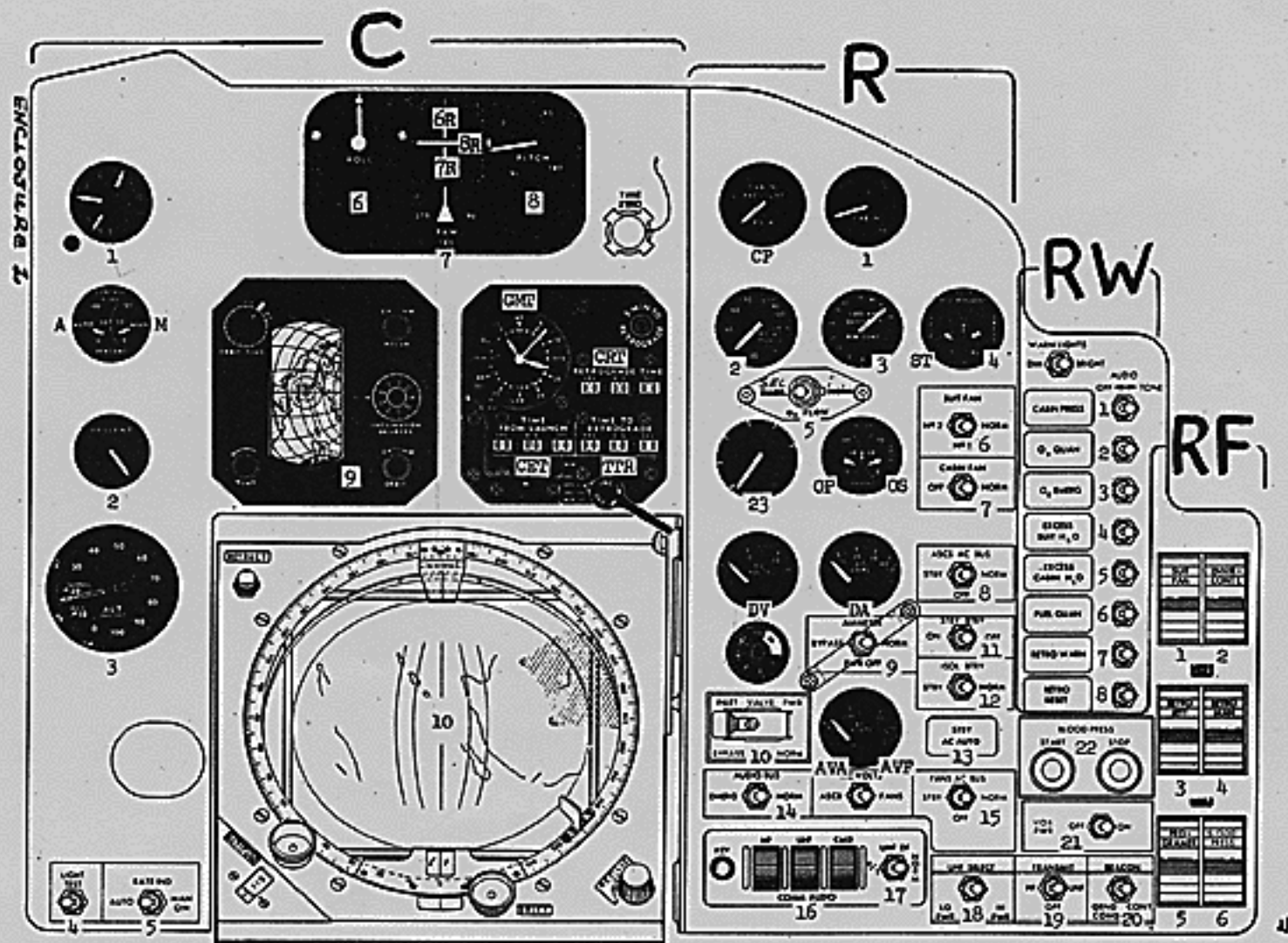
5. On page 2, time 0:04:30, under "Comments" add "Astronaut GO".
6. On page 3, time 0:08:00, under "Time" add "or ASAP after 0:06:15 activity".
7. On page 4, time 0:14:20, under "Comments" delete "CYI reports when radar solid". Add "CYI reports computer accepting radar data".
8. On page 7, time 0:54:20, under "Comments" delete "for 2 minutes".
9. On page 9, time 1:27:00, under "Comments" delete "At first contact (T/M)". Add "30 seconds prior to retrosequence time".
10. On page 13, time 2:17:00, under "Comments" revise last sentence to read "Report approximate time of flare ignition".
11. On page 13, time 2:24:00, under "Activity" delete "Orbit position information". Add "Night observation of cities".
12. On page 13, time 2:24:00, under "Comments" delete first sentence.
13. On page 15, time 2:58:00, under "Comments" delete "Decision point on third orbit". Add "30 seconds prior to retrosequence time a GO-NO GO decision is made between spacecraft and ground".
14. On page 19, time 4:22:00, under "Comments" add "Cap Com counts down to GET "mark".

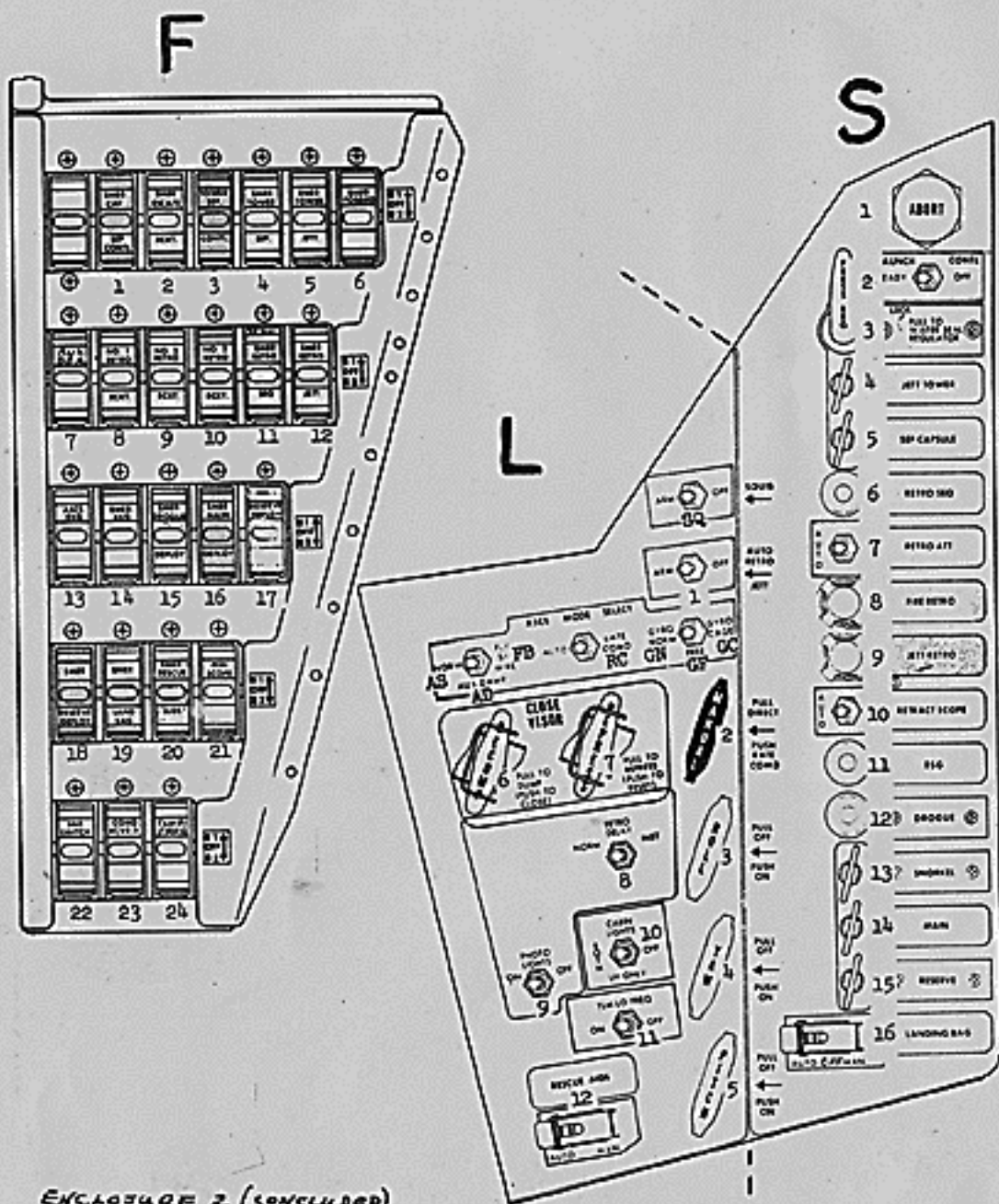
- ✓ 15. On page 20, time 4:32:00, under "Comments" add "As in Mission Rules".
- ✓ 16. On page 24, time T + 4:30, add "ASTRONAUT GO".
- ✓ 17. On page 27, time 0:08:00, add "or ASAP after 0:06:15 activity".
- ✓ 18. On page 28, under "Communications" add "CC: Reports computer accepting radar data".
- ✓ 19. On page 28, under "Spacecraft Activities", time 0:14:20 delete "for 2 minutes".
- ✓ 20. On page 49, under "Communications" delete "Give orbital parameter information".
- ✓ 21. On page 67, under "Communications", after "Clock Check" add "(Cap Com counts down to GET "mark")".
- ✓ 22. On page 68, under "Communications" delete "Possible countdown to retrofire and any other aid requested by astronaut". Add "Countdown to retrosequence and to retrosequence plus 30 seconds".
- ✓ 23. On page 89, CW Code Section E, add "R 23 Suit Heat Exchanger Exhaust Temperature".

- ✓ 24. On page 75, Reference No. 3, Orbit Checklist, Item 3 - delete "Emer".
- ✓ 25. On page 80, Reference No. 7, Preretrosequence Checklist - add "NOTE: If flight continues return item 3 to "off" and return item 5 to "off".
- ✓ 26. On page 81, Reference No. 8, Post-Retrosequence Checklist - Item 6 - Add " 30 sec after retrojett". On Item 7 - add " $T_R + 645$ sec".
- ✓ 27. On page 82, Reference No. 9, Post-Entry Checklist, Item 2 - delete "Emer" and delete "NO. 1". Add "AUTO".

Item 10 will be renumbered 7, so that checklist now reads:

6. Emer O_2 handle - EMER
 7. Fuel handles - CHECK/IN
 8. At 10,000 feet, main etc.
 9. Astronaut preparation for etc.
 10. Landing Bag telelight - GREEN
 11. Press Reg handle - PULL AND TURN
 12. UHF/DF switch - R/T
 13. Fuel dump, check etc.
- ✓ 28. On page 85, Reference No. 10, C W Code, Part II - add "RA RCS Auto" after "FB Fly-By-Wire".





ENCLOSURE 2 (CONCLUDED)

cc. R. R. R.

28 48
32 38
34 32
36 32

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
January 18, 1962

MEMORANDUM for All Concerned

Subject: Revision B to Flight Plan for Mercury-Atlas Mission 6

1. Enclosed herewith is one copy of the Revision B to the Flight Plan for Mercury-Atlas Mission 6 dated December 21, 1961.
2. This revision consists of pen and ink corrections to the Flight Plan.

Jeremy B. Jones
Flight Activities Section
Spacecraft Operations Branch

Enc:

1. Revision B

*Revised (a)
11/21/62
JBJ*

Revision B to MA-6 Flight Plan. This message in 15 paragraphs.

Para. 1: General - It has been reported that some Flight Plans dated December 21, 1961, did not reproduce completely. Flight Plan should include one cover sheet, one page with names of persons to be contacted for changes, one page of 13 Mission Rules, one page for Table of Contents, and pages numbered 1 through 109 inclusive. Ascertain that all pages noted are printed and that no blank pages exist, particularly in the consecutively numbered pages.

Para. 2: Revise Mission Rules 5 to read, "When the spacecraft is on FBW or manual proportional control, the spacecraft attitude will be kept within a 3 axis limit, a 2 axis limit, or a single axis limit as follows:

<u>Pitch</u>	<u>Yaw</u>	<u>Roll</u>
plus 60, -64 deg.	plus/minus 30 deg.	plus/minus 30 deg.
plus 60, -64 deg.	plus/minus 60 deg.	0 deg.
0 deg.	0 deg.	plus/minus 60 deg.

The yaw turnaround during second orbit will be an exception to this rule."

Para. 3: Replace the word "retrofire" with the word "retrosequence" throughout except as used in the title of reference 8. Reference 8 title should continue to read "Post retrofire checklist".

Para. 4: Page 2, times 0:03:00, 0:03:30, 0:04:00, and 0:04:30 under comments, change "cabin pressure" to read "cabin pressure holding".

Para. 5: Pages 23 and 24, times 0:03:00, 0:03:30, 0:04:00, and 0:04:30 under launch, change "cabin pressure _____" to read "cabin pressure holding". If cabin pressure does not hold, astro will give cabin pressure reading.

Para. 6: Page 3, time 0:08:00 or ASAP after 0:06:15 activity, delete "0:08:00 or". Time block should now read "ASAP after 0:06:15 activity".

Para. 7: Add the following remarks enclosed in quotes to the comments block for the pages, times, and activities indicated: 5, 0:21:00, possible overlap KNO-CYI, "Astro gets retrosequence time for area 1C"; 5, 0:30:00, 30 minute report, "Astro gets retrosequence time for area 1D"; 6, 0:40:30, Sunset 0730 launch, "Astro gets retrosequence times for areas 1E, F, and H"; 9, 1:27:00, GO NO-GO decision, "Astro gets retrosequence times for areas 2A, G, and H"; 10, 1:34:00, 30 minute report, "Astro gets retrosequence times for areas 2B and 2C"; 13, 2:14:00, observation of flare from IOS, "Astro gets retrosequence times for areas 2D, 2E, and G"; 15, 2:58:00, GO NO-GO, "Astro gets retrosequence times for areas 3A and H"; 16, 3:07:00, Blood pressure, vision, and standard 30 minute report, "Astro gets retrosequence times for Areas 3B and 3C"; 18, 3:46:00, Communications change, "Astro gets retrosequence times for Areas 3D, 3E, and H."

Para. 8: Delete the statement "Give contingency retrosequence time(s) for area(s) (designated area)" from the following station pass pages: First orbit: ZZB 32, MUC 34, WOM 35, CTN 36, GYM 38; Second orbit: EDA 43, ZZB 47, MUC 49, WOM 50, CTN 51, HAW 52; Third orbit: MCC 57, EDA 58, ATS 60.

Para. 9: Under station pass procedures add the following remarks enclosed in quotes to the CAPCOM transmission which occurs directly after the astro's capsule status report for the stations and pages indicated: First orbit: ZZB 32, "Give retrosequence time for Area 1D. Confirm Area 1C retrosequence time was received from KNO"; IOS 33, "Give retrosequence times for Areas 1E, F, and H. Confirm Area 1D retrosequence time was received from ZZB"; MUC 34, "Confirm area 1E, F and H retrosequence times were received from IOS"; GYM 38, "Give retrosequence times for areas 2A, G and H". Second orbit: MCC 43, "Give retrosequence times for areas 2B and 2C. Confirm area 2A, G and H retrosequence times were received from GYM"; EDA 43, "Confirm area 2B and 2C retrosequence times were received from MCC"; IOS 48, "Give retrosequence times for

areas 2D, 2E and G"; MUC 49, "Confirm area 2D, 2E and G retrosequence times were received from IOS"; CAL 53, "Give retrosequence times for areas 3A and H"; Third Orbit: MCC 57, "Give retrosequence times for Areas 3B and 3C. Confirm area 3A and H retrosequence times were received from CAL"; ATS 60, "Confirm area 3B and 3C retrosequence times were received from MCC"; IOS 63, "Give retrosequence times for areas 3D, 3E and H"; MUC 64, "Confirm area 3D, 3E and H retrosequence times were received from IOS".

✓ Para. 10: Reference No. 3, page 75, change item 5 to read, "Audio warning tone switches - ON"

✓ Para. 11: Reference No. 6, page 79, change item 1 to read, "Store in container if not already secured: (a) cameras, (b) light meter - visual test device - spectrometer, (c) unexposed film, (d) star navigation device, (e) food." Delete item 2. Add item 6 to read "Store in waterproof bag: (a) microfilm viewer, (b) glasses, (c) exposed film, (d) pliers".

✓ Para. 12: Reference No. 9, page 82, change item 2 to read "At 21,000 feet, drogue deployed". Change item 3 to read "Fuel handles - CHECK/IN". Change item 7 to read "At 10,000 feet, main telelight - GREEN (check main deployment visually)". ^{change} ~~item 8~~ ⁸ to read "Landing Bag Switch - AUTO". ~~item 12a~~ Add item 12a to read "VOX power-OFF".

✓ Para 13: Reference No. 9a, page 83, add item 4a to read "Store flashlight in pocket on Survival Kit". Add to item 6 "....and waterproof equipment bag".

9 - 2 -
(Para. 14: Reference No. 10, page 2 of enclosure 2 put out with Revision A to the flight plan, picture of left panel, add "RA" below the auto position of the RSCS switch.)

✓ Para. 15: Reference No. 22, page 108, items 6, 7, and 11 are now contained in one piece of equipment; list all three under item 6 and delete items 7 and 11. Delete item 14. Add to item 10 "... (in Survival Kit)". Add to item 20 "...with red filter". Add as item 29 "waterproof equipment bag".

Flight Controller's Handbook

FCH-1

REV -

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-	TABLE OF CONTENTS	B	
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-	DIAGRAM SYMBOLS	D	
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1	ENVIRONMENTAL GASEOUS SYSTEM	ECS2-1	
2	DC POWER SYSTEM	ELS1-1	
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2	ELECTRIC BUS DISTRIBUTION SUMMARY	ELS3-1	
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NO REV.

B

1 DEC. 1961

 SB 54 } transfer
 69 } office
 90 }
 53 }
 See Panel

FCH-1
REV. -

FOREWORD

THIS HANDBOOK HAS BEEN PREPARED BY MEMBERS OF THE McDONNELL AIRCRAFT CORPORATION, LANGLEY, VIRGINIA FIELD OFFICE IN ASSOCIATION WITH THE SPACE TASK GROUP OPERATIONS DIVISION. THE HANDBOOK PROVIDES FUNCTIONAL INFORMATION CONCERNING THE ~~REAR~~ MERCURY CAPSULE /S ONBOARD SYSTEMS. THE OBJECT HAS BEEN TO PRESENT THIS INFORMATION IN A CONCISE, READILY UNDERSTOOD MANNER WITH PRIMARY EMPHASIS ON THAT MATERIAL WHICH FLIGHT CONTROLLERS REQUIRE FOR OPERATIONAL USE.

~~THE HANDBOOK PERTAINS TO THE OPERATIONAL COMPLIANCE CAPSULE.~~

~~FROM TIME TO TIME ADDITIONAL PAGES WILL BE ISSUED TO BROADEN THE SCOPE OF THIS HANDBOOK BY PRESENTING OTHER INFORMATION DEEMED PERTINENT. IN ADDITION, EACH FLIGHT NIGHT CONTROLLER WILL BE FURNISHED A HANDBOOK ON EACH CAPSULE PRIOR TO THE LAUNCH OF THAT CAPSULE.~~

FCH-1
REV. -

CAUTION

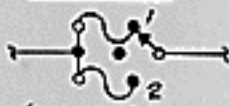
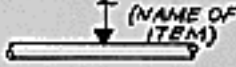
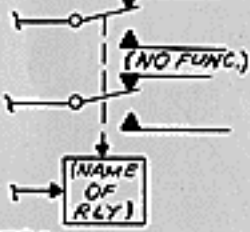
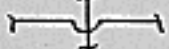
MANY OF THE CIRCUITS AND FLOW DIAGRAMS IN THIS HANDBOOK HAVE BEEN SIMPLIFIED TO DEPICT ONLY THOSE FUNCTIONAL ASPECTS PERTINENT TO FLIGHT CONTROL. BECAUSE OF THIS SIMPLIFICATION, THIS HANDBOOK SHOULD NOT BE USED FOR REFERENCE IN SYSTEMS DESIGN, CHECKOUT OR ANALYSIS.

C

Sheet 2 of 2

1 DEC 1961

FCH-I REV - DIAGRAM SYMBOLS

<u>AMPLIFIER</u>  (NAME OF AMP.)	<u>SW. FUSE</u>  (NAME OF SW. FUSE) NOTES: 1 DENOTES POS. 1 2 DENOTES POS. 2 - DOT IN CTR. OF 1 & 2 INDICATES OFF POS.	<u>PARACHUTE RISER OR LANYARD</u>  <u>POTENTIOMETER</u>  NOTES: ARROWED SOLID LINE INDICATES MECH. DRIVEN WIPER.
<u>ANTENNA</u> 	<u>HEADPHONES</u> 	<u>PULL RING</u> 
<u>ELECTRICAL BUS</u>  (NAME OF BUS)	<u>LINE SENSOR OR DETECTOR</u>  (NAME OF ITEM)	<u>RADIO SIGNAL</u> 
<u>ELECTRICAL CONNECTION</u> 	<u>MIKE</u> 	<u>RELAY</u>  (NO FUNC.) (NO FUNC.) (NAME OF RLY)
<u>ELECTRICAL CROSSOVER</u> 	<u>MISC. CONTROLLING FUNCS</u>  (NAME OF FUNC.) NOTES: ARROWED SOLID LINE INDICATES DIRECTION OF CONTACT MOVEMENT WHEN FUNC. OCCURS	NOTES: - ARROWED SOLID LINE INDICATES SIGNAL INPUT TO ACTIVATE RELAY. - SEE NOTES FOR RELAY CONTACT SYMBOL.
<u>FUSES</u> <u>PLAIN FUSE</u> 	<u>NAMEPLATE</u>  (NAME OF PLATE)	
<u>SOLID CONDUCTOR FOR FUSE</u> 		

FCH-I REV- DIAGRAM SYMBOLS



SIGNAL FLOW CONTROLLED FUNCTIONS



- NOTES:
1. ARROWED LINES INDICATE DIRECTION OF SIGNAL FLOW.
2. BLOCK INDICATES FUNC. REQ'D FOR SIGNAL FLOW TO CONTINUE

SIGNAL FLOW LINES

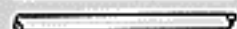
LIQUID LINE



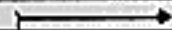
MECH. SQUIB LINE



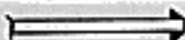
GASEOUS LINE



ELECTRICAL SIG. LINE



MECH. SIG. FLOW LINE

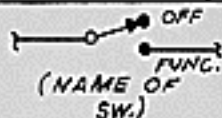


MECH. FUNC. LINE

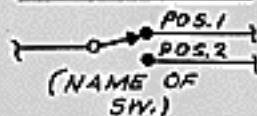


SWITCHES

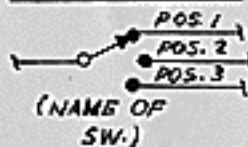
SINGLE FUNC. SW.



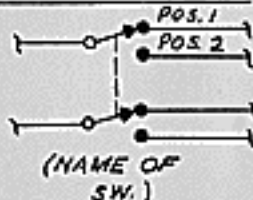
2 POSITION SWITCH



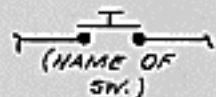
3 POSITION SWITCH



MULTIPLE POLE SW.



PUSH BUTTON SW.



THERMO OR PRESS. SW.



TEE HANDLE



TELELIGHT

(NAME OF LT.)

TELEMETERED SIG.



- NOTES:
1. HI - DENOTES HIGH FREQ. CHANNEL
2. LO - DENOTES LOW FREQ. CHANNEL

WARNING LIGHT

(NAME OF LT.)

ZENER



ELECTRIC BUS DISTRIBUTION SUMMARY
CAPSULE 13

<u>ELECT BUS</u>	<u>SYS</u>	<u>Δ FUNCTION CONTROLLED</u>
MAIN 24 VDC	ECG	*Environmental Control; Relative Humidity Indicator; Auto Suit Fan Control; Environmental Warn Light Control; Suit Temp. Meters; Suit Shutoff Valve; Water EXTRACTOR; Inlet Door Blowoff (Emer); <i>EMER. RATE LOCKING SOLENOID</i>
	ELS	AC Warn Lt Control; Emer. Hold Control; Fans Inverter; Standby Inverter; ASCS Inverter; <i>WARN LTS. TEST</i>
	SCI	H ₂ O ₂ Jettison
	INS	*Programmer
	COMM	Vox; Headset No. 1; Mike No. 1; Primary Supply to Audio Center; Primary Supply to VEF Transmitters -Receivers
	MISC	Satellite Clock; Periscope Control; *Periscope (Motor Pwr.); Periscope Reticle; Periscope Warn Light; Cmd. Reset of Satellite Clock; Retro Reset Warn Light; Retro Warn Light; 5 Min. to Retro Warn Light
MAIN ASCS 24 VDC	SCS	Fuel Quan. Warn Light CONTROL; <i>FLY BY WIRE</i> ; Gnat Rate Gyro Control
	SES	*ASCS .05g; *Emer. .05g
SEC ASCS 24 VDC	SCS	ASCS Logic; Attitude Gyro Control; Slaving Control; Aux. Damping
HYDRACT MAIN 24 VDC	ELS	3 VDC Inst. Supply; 7 VAC Inst. Supply
	SCS	RSCS Load
	SES	Velocity Sensor

ΔSee INS 1-1 for buses controlling T/M outputs
*Indicates switch fuse

(Sht 1 of 5)

FCH-1
ELS 3-1
Rev. -
1 DEC. 1961

ELECTRIC BUS DISTRIBUTION SUMMARY
CAPSULE 13

<u>ELECT BUS</u>	<u>SYS</u>	<u>Δ FUNCTION CONTROLLED</u>
PREIMPACT MAIN 24 (Cont'd)	YNS	Lo Freq. T/M Transmitter; Tape Recorder; Lo VCO Power; T/M Calib.
	COMM	T/M Command; C-Band Beacon; Command Voice; HF Transmitter-Receiver
PREIMPACT SEC. 24 VDC	SEC	Inst. Accelerometers (N_X , N_Y , N_Z)
	INS	*HI T/M Transmitter; Pilot and Instrument Camera; Earth and Sky Camera; HI Mixer Amp. and VCOs; *Blood Pressure
	COMM	S-Band Beacon
AUDIO BUS SWITCH { AUDIO 24 VDC NORM-MAIN BUS EMER-ISOL BUS	COMM	Tone Generator; HF Recovery Transmitter-Receiver; *Antenna Switch; UHF Transmitters-Receiver; Headset No. 2; Mike No. 2
STANDBY 6 VDC	COMM	*Aux UHF Beacon
STANDBY 12 VDC	COMM	HF Beacon
STANDBY 18 VDC	COMM	Lo Comd. Receiver Decoder
ISOLATED 6 VDC	ELS	Seq. T/M 3 VDC Supply
	COMM	UHF Beacon
ISOLATED 18 VDC	COMM	*HI Comd. Receiver Decoder
WARN LIGHTS 12/24 VDC	SCS	Warn Lights; Cabin Pressure; O_2 Quan; O_2 Emer; Excess Suit H_2O ; Excess Cabin H_2O
	ELS	Warn Lights: Standby AC Auto
	SCS	Warn Lights: Fuel Quan

(Sht 2 of 5)

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ELECTRIC BUS DISTRIBUTION SUMMARY
CAPSULE 18

<u>ELECT BUS</u>	<u>SYS</u>	<u>Δ FUNCTION CONTROLLED</u>
WARN LIGHTS 12/24 VDC (Cont'd)	SES	Tealights: Abort; Jett Tower; Sep. Capsule; Retro Seq.; Retro Attitude; Fire Retro; Jett Retro; .05g; Landing Bag; Rescue Aids; MAIN CHUTE
	MISC	Warn Lights: Retro Reset; Retro Warn; RETRACT SCOPE
INST. SUPPLY 3 VDC	ECG	Guit O ₂ Meter; Primary O ₂ Meter; Sec. O ₂ Meter; COOLANT QUANT. METER ; Press. Meter
	SCS	Manual Fuel Meter; AUTO FUEL METER ; ATT. METER ; Control Stick Signals
MAIN SQUIB 24 VDC	ECG	Cabin Vent Valves; Inlet Air Door Blowoff
	SES	Tvr. Sep. Control; Tvr. Sep. Bolts; Tvr. Escape Rockets; Tvr. Jett. Rockets; Capsule Sep. Control; Capsule Adapter Umbilical; Capsule Sep. Bolts; Postgrade Rockets; Retro Seq.; No. 1, 2 and 3 Retrorockets Fire; Auto Retro Jettison; Retrorocket Assy Umbilical; Retrorocket Assy Jettison; Auto Drogue Deploy; Auto MAIN CHUTE SYS. LOCKOUT ; Antenna Pairing Switch; Antenna Pairing Eject; Antenna Pairing Sep.; Auto Main Chute Deploy; Main Chute Eject Bag; Landing Bag Extend; Auto Landing Bag Control; Inertia Switch; Impact Signal

(Sht 3 of 5)

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1 DEC 1961

ELECTRIC BUS DISTRIBUTION SUMMARY
CAPSULE 13

<u>ELECT BUS</u>	<u>SYS</u>	<u>Δ FUNCTION CONTROLLED</u>
MAIN SQUIB 24 VDC (Cont'd)	SES	Main Chute Disconnect; Reserve Chute Disconnect; Rescue Aids; Reserve Chute Deploy Gun; Reserve Chute Eject Bag; *Reserve Deploy; Whip Antenna; Max. Alt. Sen.; Thrust Sensor; *EMER. RETRO SEQ.; RETRO SEQ. OVERRIDE; GND. CMD. OF RETRO SEQ.
ISOLATED SQUIB 24 VDC	ECG	Cabin Vent Valves; Inlet Air Door
	SES	Abort Control; *Tvr. Sep. Control; *Emer. Tvr. Sep.; *Emer. Tvr. Escape Rockets; *Emer. Tvr. Jettison Rockets; *Emer. Cap. Separation Control; Emer. Cap. Adapter Umbilical; Emer. Cap. Sep. Bolts; *Emer. Postgrade Rockets; WHIP-ANTENNA; *EMER. RETRO JETT.; No. *1, *2 and *3 Retro Rockets Fire; *Retro Manual Control; *Retro Rocket Jettison; Auto Drogue Deploy; *Emer. Drogue Deploy; Emer. Drogue; Auto Main System Lockout; Emer. Ant. Pairing Eject; Auto Main Chute Deploy; *Emer. Main Chute Deploy; Emer. Main Eject Bag; Emer. Landing Bag Extend; *Emer. Landing Bag; Emer. Main Chute Eject Bag; Emer. Inertia Switch; Emer. Main Chute Disc.; Emer. Reserve Chute Disc.; *Emer. Rescue Aids; Emer. Reserve Deploy Gun; Emer. Reserve Eject Bag; *Emer. Reserve Deploy; Post Landing System; Emer. Ant. Pairing Switch
PANEL 115 VAC	ECG	Cabin Fans; Humidity Indicator; *Sulf Fans
	ELS	Cabin Lights; Photo Lights
	SCS	Rate Indicator; <i>SWAY RATE GYRO</i>
	SES	Max. Altitude Sensor; Velocity Sensor

(Sht 4 of 5)

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ELECTRIC BUS DISTRIBUTION SUMMARY
CAPSULE 13

ELECT BUS

SYS

Δ FUNCTION CONTROLLED

ASCS 115 VAC

SCS

Attitude Gyros; Attitude Indicators;
Amp. Cal.; **ASCS RATE GYROS; MARION**
Scanners; **SCANNER HEATERS**

MAX. ALT.
SEN. BATT.

SES

Max. Alt. Sensor.

(Sht 5 of 5)

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SYSTEM ELECTRICAL LOADS

CAPSULE 13

METHOD OF
CONTROLLING LOADSYSTEMELECTRICAL
LOAD

CABIN LTS.

.7 AMP.

CABIN LTS. SW. ; L.H. ONLY
WOULD TURN OFF HALF OF LOAD.

PHOTO LTS.

.7 AMP.

PHOTO LTS. SW.

CABIN FAN

1.1 AMPS.

CABIN FAN SW.

HI FREQ. TM XMIT.

1.6 AMPS.

TLM HI FREQ. SW. FUSE

LO FREQ. TM XMIT.

1.6 AMPS.

TLM LO FREQ SW.

SUIT FAN

2.8 AMPS.

EMER. O₂ RATE ON WHICH
TURNS OFF FAN BUT PROVIDES
NECESSARY ENVIR. CONDITIONS

RATE INDICATORS

.8 AMP.

RATE IND. SW.

C & S BEACONS

2.3 AMPS.

BEACON SW. ; LOAD FOR WHEN
GND. INTERROGATING; 2.0 AMPS;
W/O INTERROGATION.

HF XMIT.

1.4 AMPS.

XMIT. SW. ; LOAD DURING XMIT.

UHF HI XMIT.

1.0 AMPS.

XMIT. SW. & UHF SELECT SW. ;
LOAD DURING XMIT.

UHF LO XMIT

.5 AMP.

XMIT. SW. & UHF SELECT SW. ;
LOAD DURING XMIT.

PROGRAMMER

.2 AMP.

PROGRAMMER SW. FUSE; ALSO
ELIMINATES FREQ. TRANSIENTS
OF 6 AMPS.

PERISCOPE

2.1 AMPS. (EXT.)
2.9 AMPS. (REF.)PERISCOPE SW. FUSE; LOADS
EXIST ONLY DURING 5 SEC.
OF OPERATION.

FAN'S BUS

7.8 AMPS.

FAN'S AC BUS SW. & EMER. O₂
RATE ON TO REPLACE LOST FAN'S.

ASCS BUS

10.2 AMPS.

ASCS AC BUS SW. ; 9.3 AMPS.
W/O SLAVING; PILOT MUST USE
MAN. CONT.

FBW OR RSCS

.9 AMP.

FBW - ASCS MODE SW. & ASCS
AC BUS SW.
RSCS - ASCS AC BUS SW. &
ASCS/RSCS SW.NOTE - SYSTEMS NOT LISTED UTILIZE
LESS THAN .1 AMP.

FCH-1

ELS 4-1

REV. -

1 DEC. 1961

THE Day of the Flight ~~Being~~ Cleared
Walter C. Williams
Associate Director for Operations, NASA
Corrections made by phone to
by W.C. Williams & R. Power
12/16/61 12/18/61

CAPE CANAVERAL -- After days of intense preparation the giant Atlas launch vehicle stood on the pad ready for flight, the Mercury spacecraft riding atop its monolithic height. The gantry still enclosed it. Scores of technicians completed the last minute details of checking and rechecking.

The astronaut was awakened at 2 a.m. and dressed for the first American orbital flight around the earth -- a flight for which he had spent more than two years training under the direction of the National Aeronautics and Space Administration.

Medical sensors were attached to his body to record heart beat, respiration and body temperature ^{and blood pressure}. After getting into his space suit he entered a medical van equipped with a "vibrating chair" to insure normal circulation. In the van he was also given last minute medical checks. A little after 5 a.m. he was taken to the launch site. At 6:30 a.m. he took the gantry elevator to the third level, entered the spacecraft and with the help of the astronaut medical official and technicians, fitted himself into the astronaut couch.

Under his Mercury spacecraft the big Atlas was poised for the journey into space. The Atlas is the oldest, most tried and tested ^{of} American launch vehicles. Atlas stands 82.5 feet (24 meters) high, is 10 feet (3 meters) in diameter and at launch weighs 260,000 pounds (119,000 kilograms). It is powered by two booster engines producing 150,000 pounds (68,000 kilograms) of thrust each and by one sustainer engine producing 60,000 pounds (27,200 kilograms) of thrust. It is fueled with kerosene and liquid oxygen.

In the Mercury Control Center and the launch pad blockhouse the countdown was going on. On his couch the astronaut made his pre-flight checks of the instruments over which he had manual control -- communications, the escape system, temperature, horizon scanner units, retro rockets, repressurization, flight instruments and spacecraft attitude control. He was in voice communication with two other astronauts, one in the blockhouse and the other in the control center. They were friends and friendly voices. They knew the program equally as well as he and he would be in

voice contact with them for most of his flight.

With the final checks completed, the technicians bolted down the hatch of the spacecraft, filled the cabin with oxygen and made a final inspection of the exterior. As they left the gantry was pulled back and the final stages of the countdown began.

The technicians in the blockhouse were responsible for the actual launching of Mercury-Atlas. Once the vehicle left the pad, control passed to the Mercury Control Center, a large, instrumented room at Cape Canaveral. At one end is a large ^{The front} parabolically curved ^{World} map marked with the plan of the orbital flight.

In front of the flight plan a battery of instruments and panels were manned by a score of launch technicians. There, also, ^{was} ~~the Range Safety Officer and the~~ ^{Director,} Flight Controller. Back of them and separated by a glass partition, were some 50 observers. Directly overhead were two closed-circuit television sets focused on the launching pad. ^(Director and his team of Flight Controllers) ~~The Flight Controller, with the Safety Officer and the technicians~~ had responsibility for the following:

Monitoring the flight from launch to re-entry; monitoring the astronaut and spacecraft status; initiating an abort (escape) decision; determining procedures which would follow an abort; monitoring re-entry; informing astronaut on mission progress; coordinating communications facilities; informing recovery forces.

The countdown for the first orbital flight followed normal procedures. In the final minutes the various stations in the blockhouse gave the favorable reply -- "Medical, go," "Telemetry, go," "Pressure, go," and so on. After the last second, the Atlas vehicle lifted slowly into the air, its base shrouded in flames and smoke. Rapidly accelerating under full power, it arched out over the Atlantic ocean.

Launch time in rocketry parlance is "T-time." At T plus 2 minutes the space vehicle was at an altitude of 210,000 feet (61,750 meters) and 45 miles (75 kilometers) down range. The booster engines burned out and dropped. ~~The danger inherent to launch and full-powered flight was over.~~ The escape tower was jettisoned.

At T plus 5 minutes the vehicle was at orbital altitude, approximately 90 miles ^{high} (150 kilometers), some 435 miles (7,250 kilometers) down range and its speed was 17,500 miles (28,160 kilometers) an hour. The sustainer engine burned out, and ^(was turned) ~~the~~ attitude jets, ~~the sustainer engine~~ the Mercury spacecraft into orbital position, that is, blunt nose forward as opposed to the launch position of blunt nose downward.

bit the astronaut had ~~almost~~ complete control over the spacecraft. He ~~could~~ continually correct ^{it} its attitude as necessary. He ~~could~~ look ^{out} the viewing port and into his ~~communication~~ periscope, reporting what he saw to the Control Center and to the tracking stations along the way -- cloud formations, storms, coastlines and continents, various celestial bodies. He checked other controls constantly. He ate and drank from squeeze tubes.

the North Atlantic ocean,
His route took him over ~~England, France, Italy,~~ Africa (~~Algeria~~), the Indian Ocean, ^{*Australia*} ~~the Pacific~~, the Pacific and back to the Western Coast of North America. At T plus 90 minutes he completed his first orbit, crossing southeast of Bermuda. At T plus 180 minutes he completed his second orbit, crossing several hundred miles farther south of Bermuda.

At T plus 250 minutes (approximately) the Mercury spacecraft was 370 miles (6,165 kilometers) west of the California coast and the astronaut prepared for his 3,000-mile (50,000-kilometer) descent course back into the atmosphere. He tilted the blunt nose of the Mercury upward ³⁵ ~~about 35~~ degrees and fired the retro rockets which slowed his speed and dropped the spacecraft out of orbit. He then ^{*changed*} ~~corrected~~ his ^{*spacecraft*} attitude so that the blunt, heat-ablating nose of Mercury was pointing ^{*correctly*} ~~downward~~. He was ready for re-entry and recovery.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER



ASTRONAUT JOHN H. GLENN, JR.
FRIENDSHIP 7

FEBRUARY 20, 1962





John Herschel Glenn, Jr., was born at Cambridge, Ohio, July 18, 1921. Now, 40 years later, he has become the first American to orbit the earth.

During the interim, he has lived an exciting life and dedicated almost 20 years to the service of his country.

He attended primary and secondary schools at New Concord, Ohio, and, in addition, attended Muskingum College there.

The 5-foot 10-1/2 inch tall astronaut has red hair and green eyes and weighs 168 pounds.

Glenn entered the Naval Aviation Cadet Program in March 1942, and was graduated and commissioned in the Marine Corps a year later. Following advanced training, he joined Marine Fighter Squadron 155 and spent a year flying F4U fighters in the Marshall Islands. During his World War II service he flew 59 combat missions.

Following the war, he was a member of Fighter Squadron 218 on North China patrol and had duty in Guam. From June 1948 until December 1950, he was an instructor in advanced flight training at Corpus Christi, Texas. He then attended Amphibious Warfare Training School at Quantico, Virginia.

In Korea he flew 63 missions with Marine Fighter Squadron 311, and 27 while an exchange pilot with the Air Force in F-86 Sabrejets. In the last 9 days of fighting in Korea, he downed three MIGs in combat along the Yalu River.

After the end of the Korean action, Glenn attended Test Pilot School at Patuxent River, Maryland. After his graduation he was project officer on a number of aircraft. He was assigned to the Fighter Design Branch of the Navy Bureau of Aeronautics in Washington from November 1956 until April 1959,

during which time he also attended the University of Maryland. In April 1959 he was selected as one of the seven Project Mercury astronauts.

John Glenn has been awarded the Distinguished Flying Cross on five occasions and holds the Air Medal with 18 clusters for his service during World War II and the Korean action.

In July 1957, the Marine Lieutenant colonel, while project officer on the F8U, set a transcontinental speed record from Los Angeles to New York, spanning the country in 3 hours and 23 minutes. This was the first transcontinental flight to average supersonic speed. He has more than 5,100 hours of flying time, including 1,600 hours in jet aircraft.

Glenn's selection as one of the Mercury Astronauts was, in itself, an honor. Records of more than 500 Air Force, Navy, Marine, and Army pilots who had graduated from test pilot school were screened by National Aeronautics and Space Administration officials and only 110 met all seven basic requirements which had been set up.

A further screening and processing program was instituted and, eventually, the seven who demonstrated the most outstanding professional background and knowledge in relationship to the anticipated job requirements were chosen.

Since that time, John Glenn, Jr., has twice been named to the role as back-up for teammates Alan B. Shepard, Jr., and Virgil I. "Gus" Grissom, who were pilots on America's two suborbital manned space flights. On November 29, 1961, Manned Spacecraft Center Director Robert R. Gilruth named him as the pilot of the first orbital mission - a mission which was to be eventually flown on February 20, 1962.



Two of John Glenn's staunchest supporters have been his children - David, 16, and Carolyn, 14.

Lynn is pictured above in front of the fireplace in the Glenn residence in Arlington, Virginia, with a family favorite - Chipper. She is in the ninth grade at Williamsburg Junior High School and her principal hobbies are churchwork and art. During the recent tour of the family with the astronaut, Lynn was notified at the Newark Airport that she had been elected president of her class.

Dave, at the left, is a sophomore at Yorktown Senior High School. He is active in sports and church youth activities, and one of his favorite hobbies is model making.

Both of the younger Glenns, although kept extremely busy on the recent tour, seemed most unaffected by all the attention showered on the party. They were tremendously impressed by the skyline view from their suite high in the Waldorf Astoria Towers, as well as by the giant ticker-tape parade in New York, the throngs lining the streets during the rainy Washington, D.C. parade, and the crowds which gathered in the little community of New Concord, Ohio, to pay tribute to Astronaut John Glenn, his wife, and his family.



The Glenn family is one which is very close with many common interests. Every member of the family is active in church-work and they attend the Little Falls Presbyterian Church in Arlington.

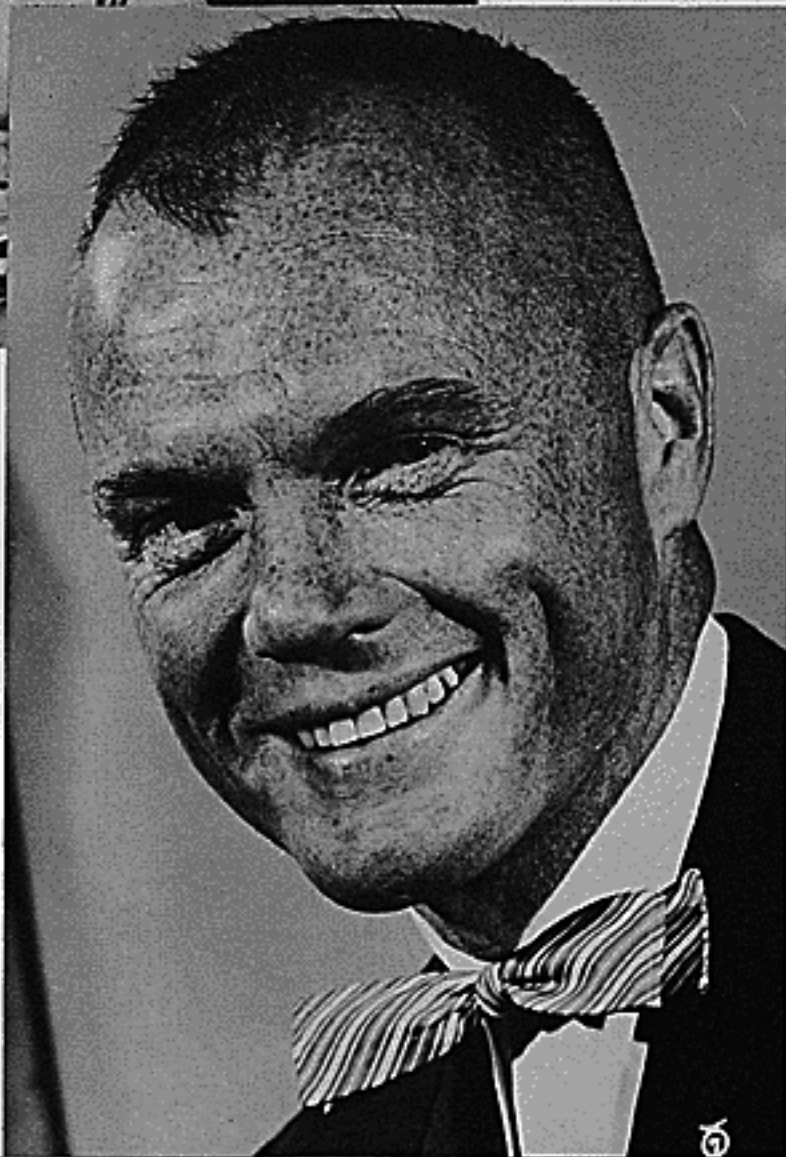
As a family they share many hobbies - water-skiing, boating, and camping, among others.

Lynn, Annie (whom John Glenn has frequently referred to lately as "The Rock of the Family"), and David are shown above in their home; while a favorite portrait of the now famous astronaut is at the right.

An example of the manner in which the family reacts was brought to light recently during a press conference for the astronauts' ladies. In answer to a query, Annie said "Sure," when asked if she'd like John to go again. When asked about the possibility of David becoming an astronaut she said, "He knows a lot about it."

A little later Lynn was asked if she would like to become a female astronaut; she also said, "Sure."

As the tour came to a close in Washington it was typical that such a close family should be close together.





AMERICA'S MOST FAMOUS TEAM - THE PROJECT MERCURY ASTRONAUTS are pictured above in front of one of their favorite training vehicles - the U.S. Air Force's F-106 jet fighter plane. Left to right: M. Scott Carpenter, L. Gordon Cooper, Glenn, Virgil I. "Gus" Grissom, Walter M. Schirra, Jr., Alan B. Shepard, Jr., and Donald K. "Deke" Slayton. Americans have long had their favorite teams in many sports but this team of space pioneers has found a universal following of many millions.

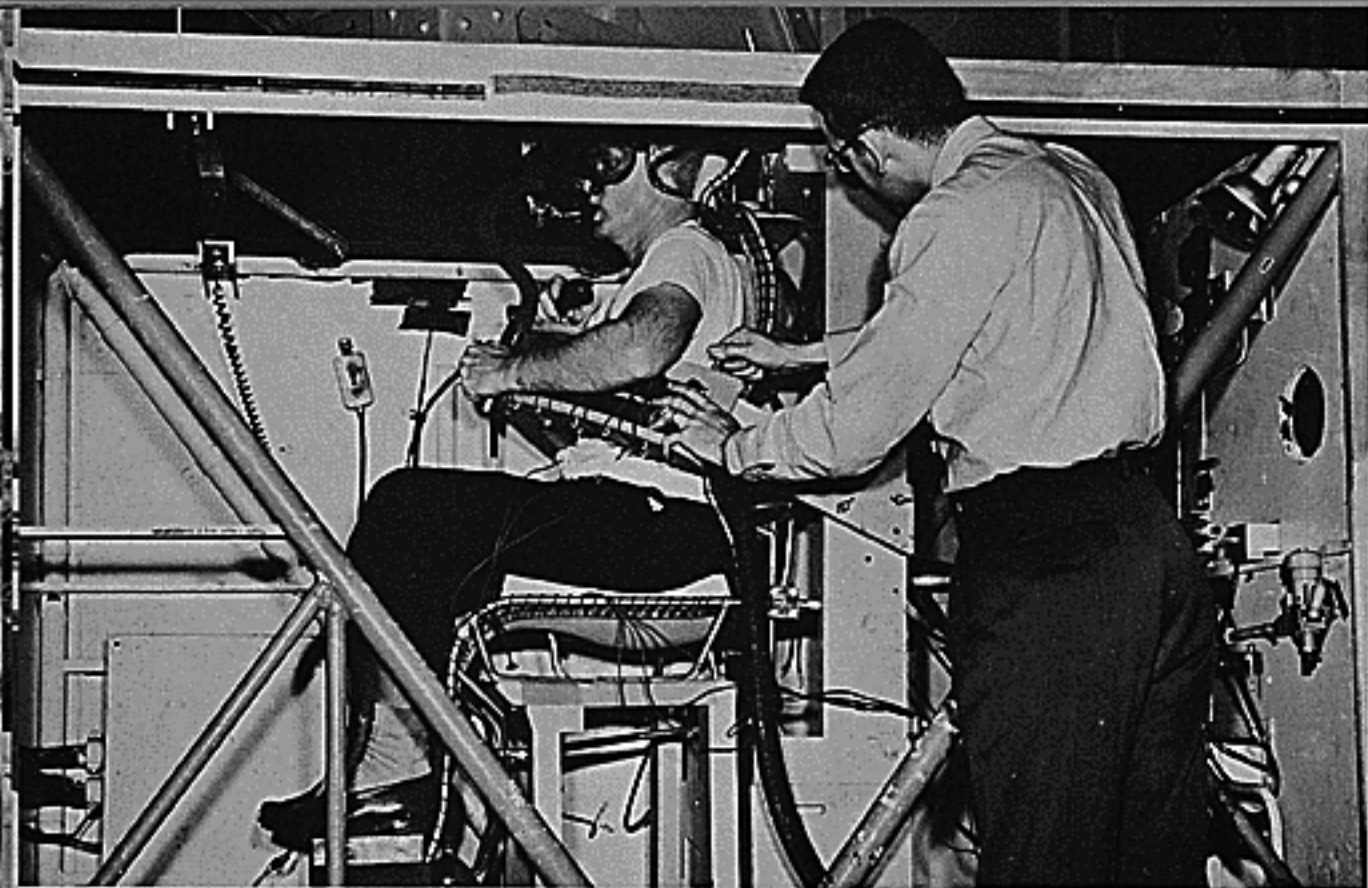
At the right, Astronaut John H. Glenn, Jr., prepares to get into the cockpit of an F-106 at Langley Air Force Base, Virginia.

On the page at the right, the picture at the top shows the activities in the crew quarters in Hangar S at Cape Canaveral as Glenn's suit is pressure checked to insure against any possible leaks during flight. Such checks are made at frequent intervals on all the astronaut equipment. At lower left Glenn clown's a bit as he dons the suit with which he has become so familiar. At lower right, in contrast, is America's first orbital pilot — serious, suited up and ready to don his helmet and to go to work.

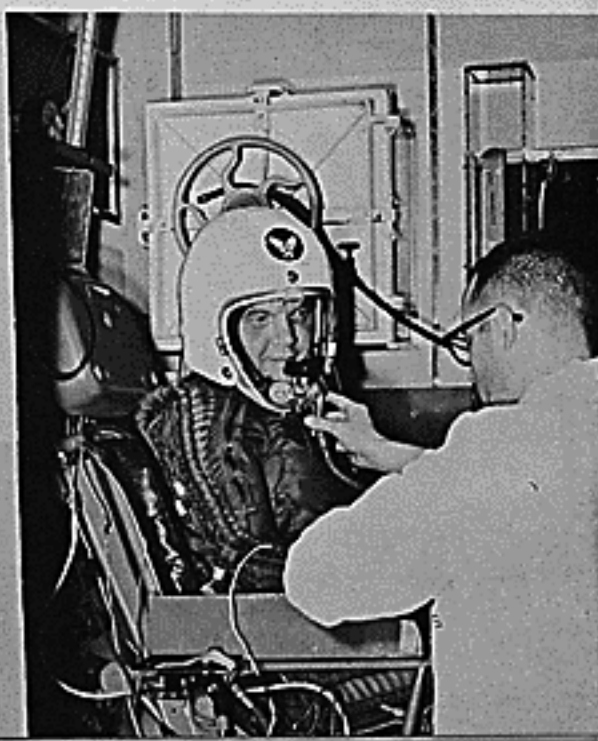
Glenn's faculty of being able to come up with a ready bit of camaraderie at any time proved its worth during his long wait for the orbital mission to become a reality. While others connected with Project Mercury, news representatives, and the general public fretted and fussed over the delay, Glenn continued in his training with the philosophy that "there'll be another day."





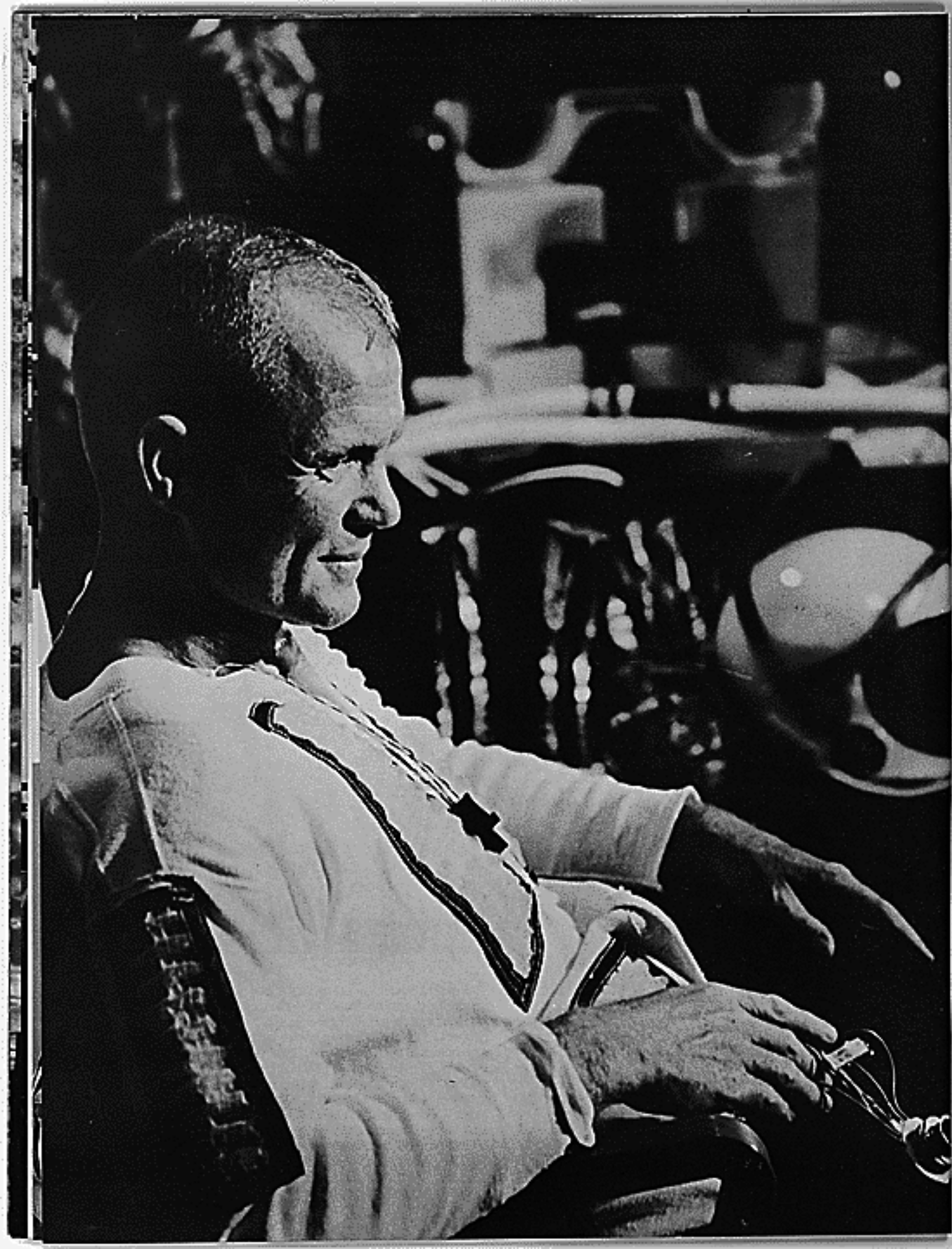


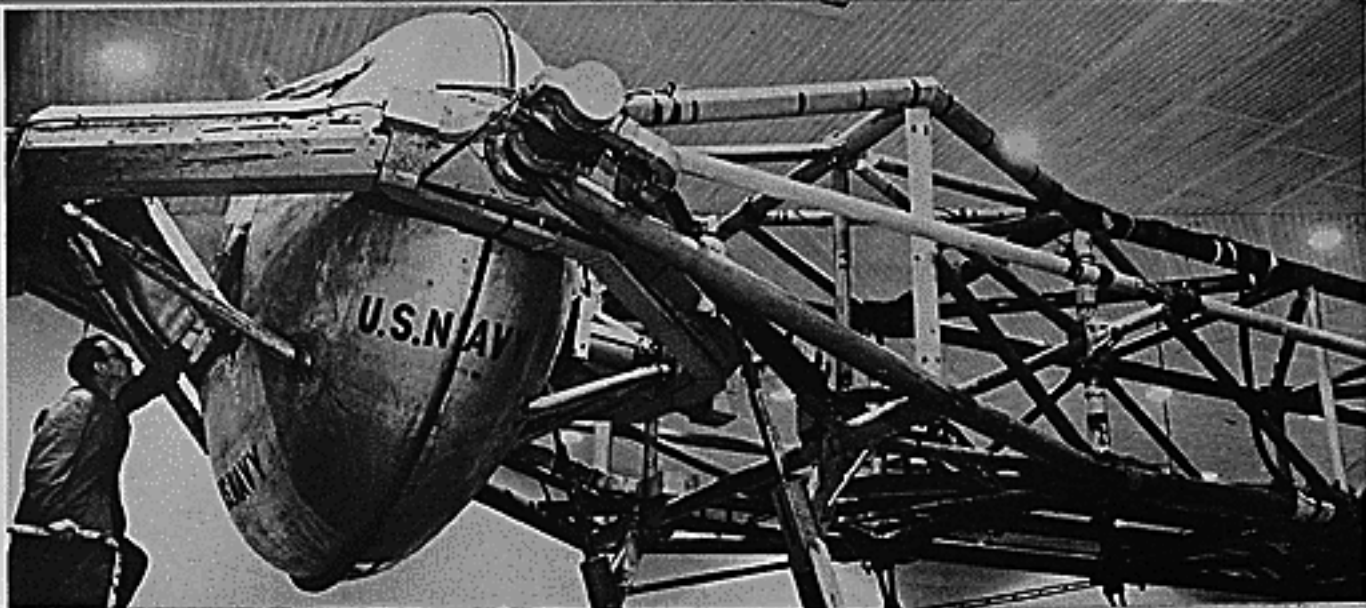
GLENN IS SHOWN ABOVE in a small centrifuge device, at lower left at a reaction measurement device, and at the lower right in a pressure chamber rig undergoing just a few of the many tests which were administered prior to the selection of the seven-man team. These tests were given to 32 men who were considered to be qualified by education and experience. The tests were designed to expose the volunteers for the space program to the stresses which were anticipated during suborbital and orbital flights. The successes registered to date by Astronauts Shepard, Grissom, and Glenn during Project Mercury missions tend to give validity to the tests and the other qualifications prescribed by NASA officials.



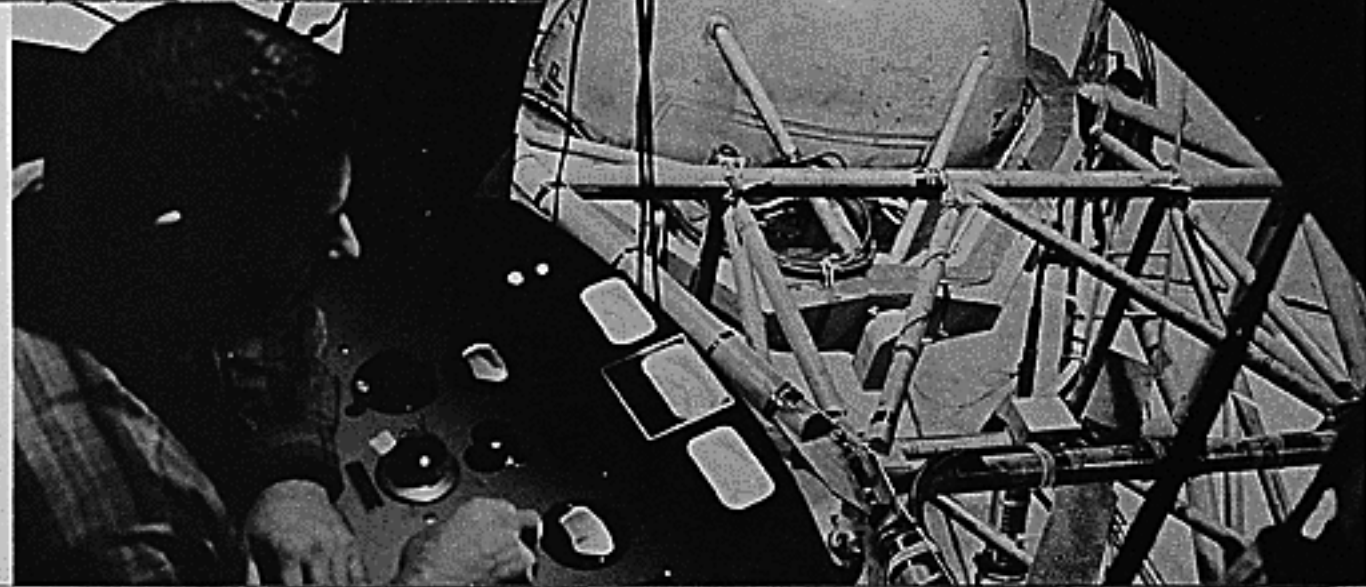


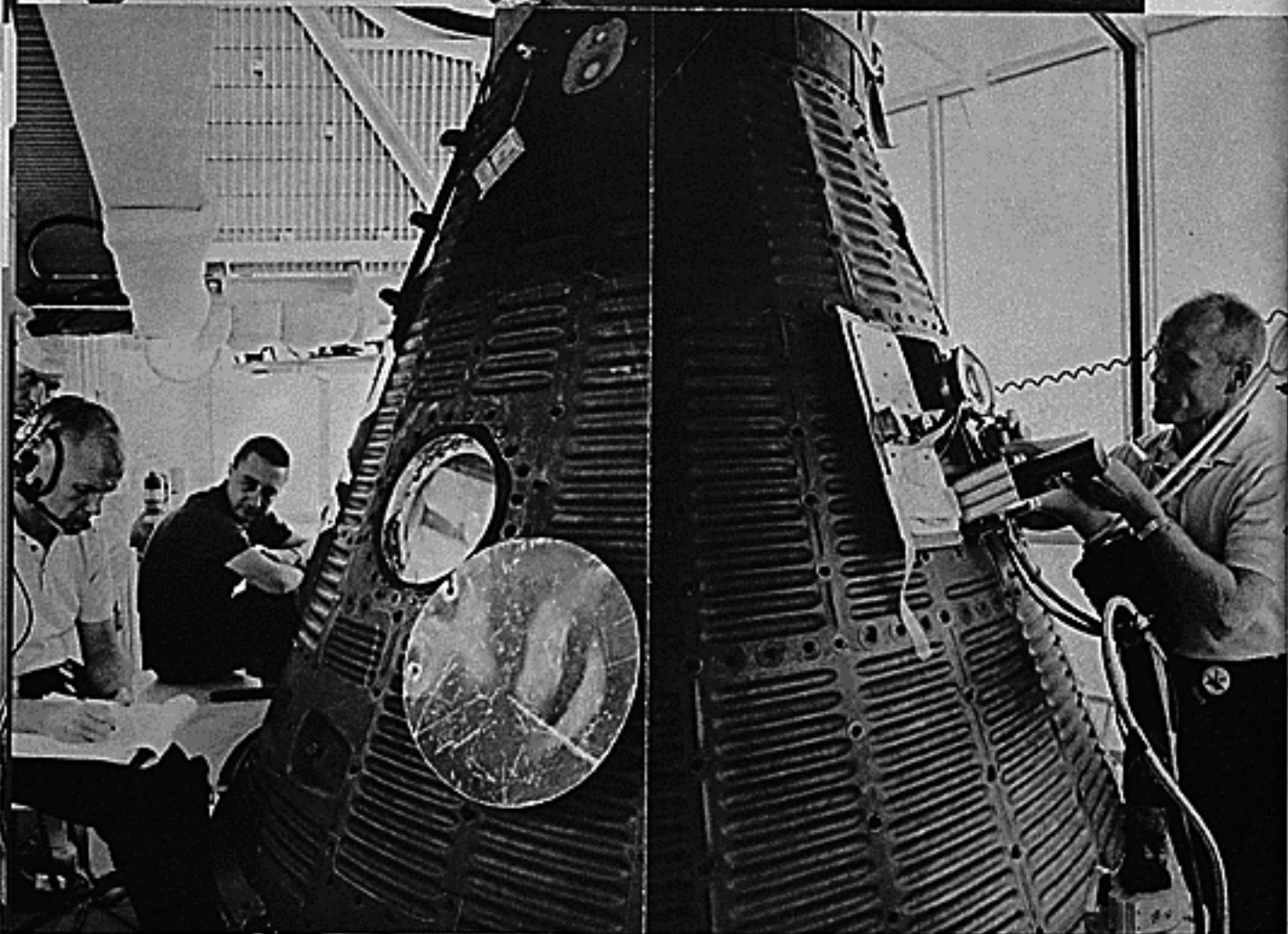
Infinite care is taken with the astronaut's suit - probably the most important part of his equipment and an item which must, of necessity, be perfect in every respect. Glenn is shown above being given an assist by Astronaut Alan B. Shepard, Jr., first Project Mercury suborbital pilot, and Joe Schmitt, crew equipment specialist, as they check all the many straps to insure that all is in order for the test. Similar exercises are held prior to each test, insuring both the reliability of the suit and the procedures involved. At the left, the freckle-faced astronaut's eyes seem to smile as he apparently enjoys a period of relaxation after being declared ready for a simulated flight. The hose attached to his left side leads to the portable air-conditioner.





CENTRIFUGE TRAINING, conducted at the Johnsville, Pennsylvania, Naval Air Station, prepares the astronauts physically and psychologically for the G-forces they encounter at lift-off and reentry. The centrifuge at Johnsville is capable of activity which produces 16 Gs, and can simulate the pressure, noises, and acceleration of space flight in the gondola. In the case of Glenn in the centrifuge, at maximum performance, his normal weight of 168 pounds would be increased to 2,688 pounds. During Project Mercury missions to date maximum G-forces encountered have been about 8 Gs.







FREEDOM

7



All personnel seem to be pleased as Glenn points out the results of some systems check-outs to Gus Grissom, Al Shepard, and Dr. Bob Voas as they discuss plans for America's first manned suborbital flight in the top picture at the left. Below at the left, Glenn records the results of a procedures trainer test. As back-up pilot for Shepard for the Mercury-Redstone 3 flight, John Glenn played a vital role in making systems checks prior to "okaying" the spacecraft as ready for the flight. He is shown above, in the White Room at Hangar S with a McDonnell engineer, as they check the progress of a systems test in Shepard's Freedom 7 spacecraft, keeping in constant voice communication with the astronaut inside. One of the many requirements for the astronauts is that they possess necessary engineering ability to check out all of the many intricate systems in the spacecraft, as well as to make recommendations to NASA and McDonnell engineers as to what systems changes are indicated for improvement. At the right, a stocking-footed Glenn assists Shepard into the spacecraft prior to one of the many tests run in the dust-free "White Room." Every possible precaution is taken to insure that no particles of dust are allowed to reach the highly sensitive equipment of the spacecraft's systems.



ASTRONAUT PARTICIPATION in the activities at Mercury Control Center is shown with Alan Shepard at the Capsule Communicator's Console during the Grissom flight. As Capsule Communicator, Shepard was in constant voice contact with Gus during most of his suborbital flight. During this period, Glenn, who had been back-up pilot for Grissom, was seated behind Shepard and also served as back-up Capsule Communicator during the flight. Also shown in the photo are other Project Mercury personnel at the many consoles in the Control Center, which serves as the hub of all activities during the flight from lift-off through recovery - the place where the experts in many fields keep in close touch with both the physical condition of the astronaut and the performance of many of the spacecraft's systems. Adjacent to the operations room, shown here, is the recovery room in which the flight is plotted and the landing area predicted.

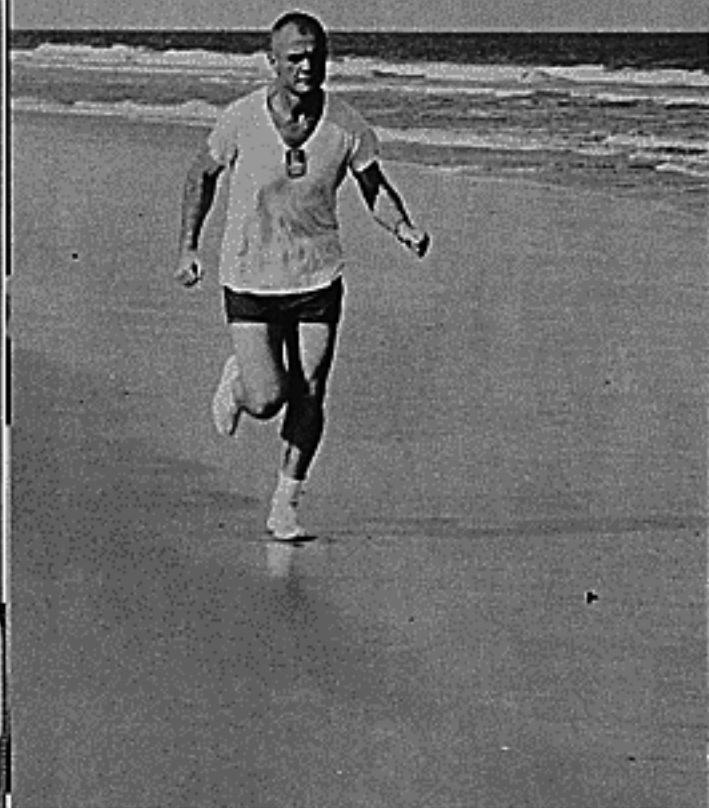
At the right, Glenn is pictured studying the flight plan while listening to the conversation between Grissom and Shepard. The astronauts on each Mercury mission have specific assignments to carry out, such as making exterior observations, eating, making periodic reports on the various systems, manual control of the spacecraft, and many other duties.





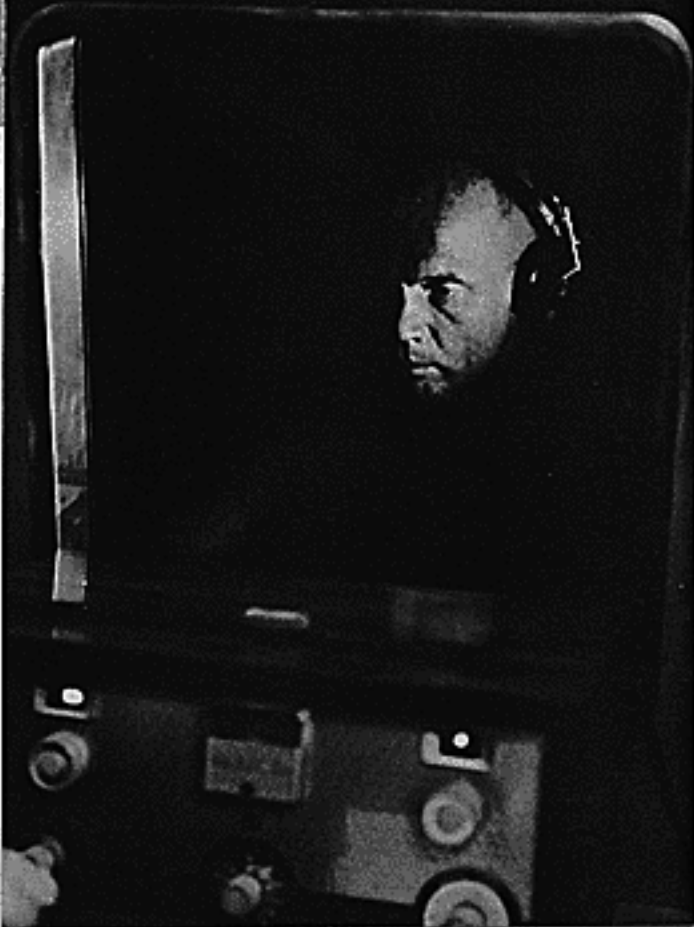
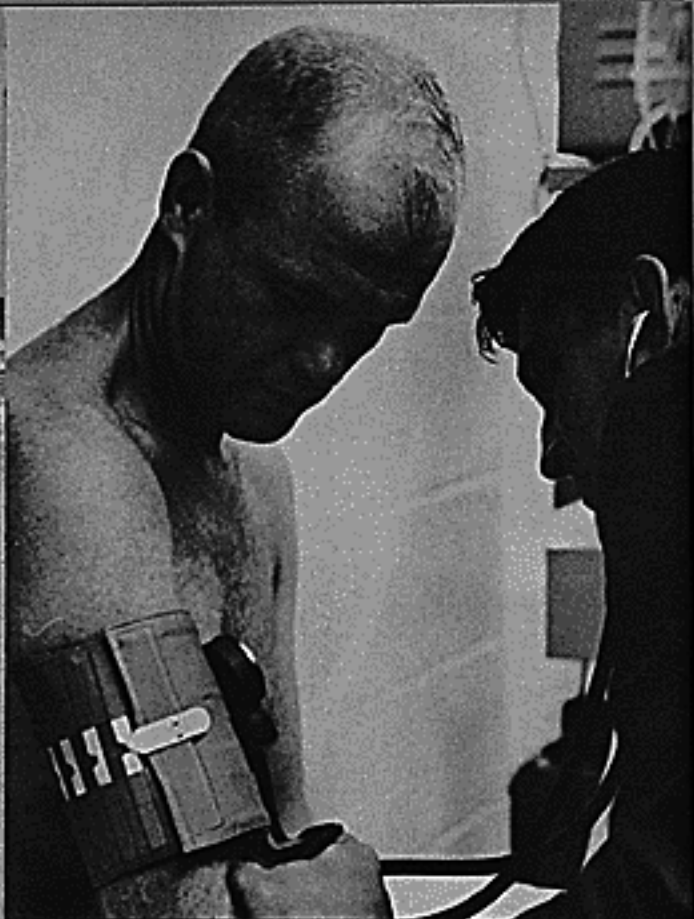
ASTRONAUT Gus Grissom, arriving in the "White Room" for one of the frequent tests made prior to the Mercury-Redstone 4 flight on July 21, 1961, is greeted by a smiling John Glenn as he nears his Liberty Bell 7 spacecraft. Gus is carrying the portable air conditioner which keeps the astronauts comfortable from the time they suit up until they are inserted in the spacecraft. At the right, Glenn helps Gus into the spacecraft.

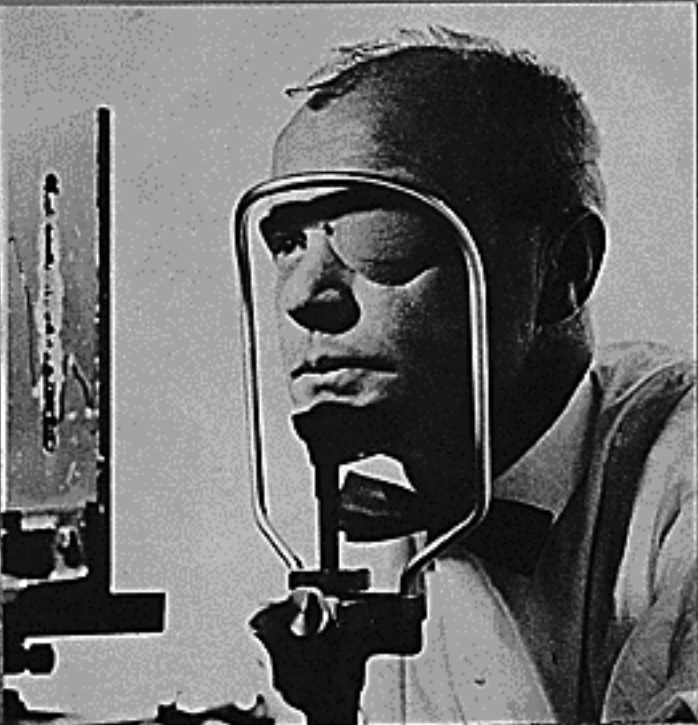


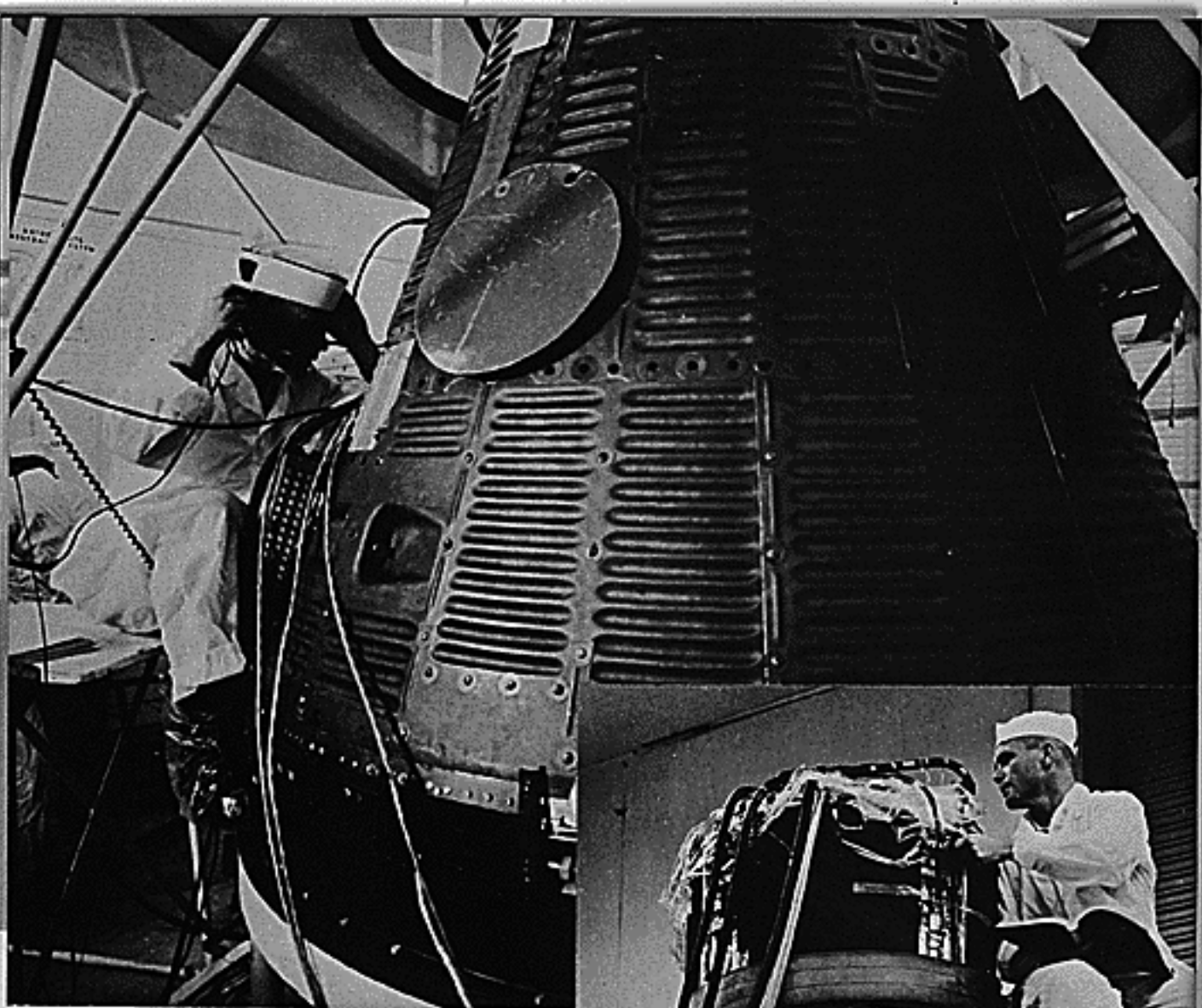


MEDICAL EXAMINATIONS and physical training for the astronauts are not just a means of qualification for the Project Mercury program, but rather a continuing process. Glenn is shown above as he runs several miles each morning and afternoon, when the schedule permits, on the beach at either Cape Canaveral or at Cocoa Beach. At upper and lower right he is pictured going through several of the many medical tests given the astronauts in several phases prior to flight on any of the Mercury missions - these tests are required to make certain that the pilot of the spacecraft is in top physical condition for the flight.

On the page at the right, Glenn is shown as he recently went through a series of demanding medical examinations, along with back-up pilot M. Scott Carpenter, at the U.S. Naval School of Aviation Medicine at Pensacola, Florida. These pictured tests serve to illustrate the thoroughness and variety of physical tests all the astronauts go through periodically to assure they are in top shape and physically capable of continuing in the exacting program. The importance of having excellent eyesight is stressed. The condition of all three astronauts who have completed space flights attest to the effectiveness of this program.

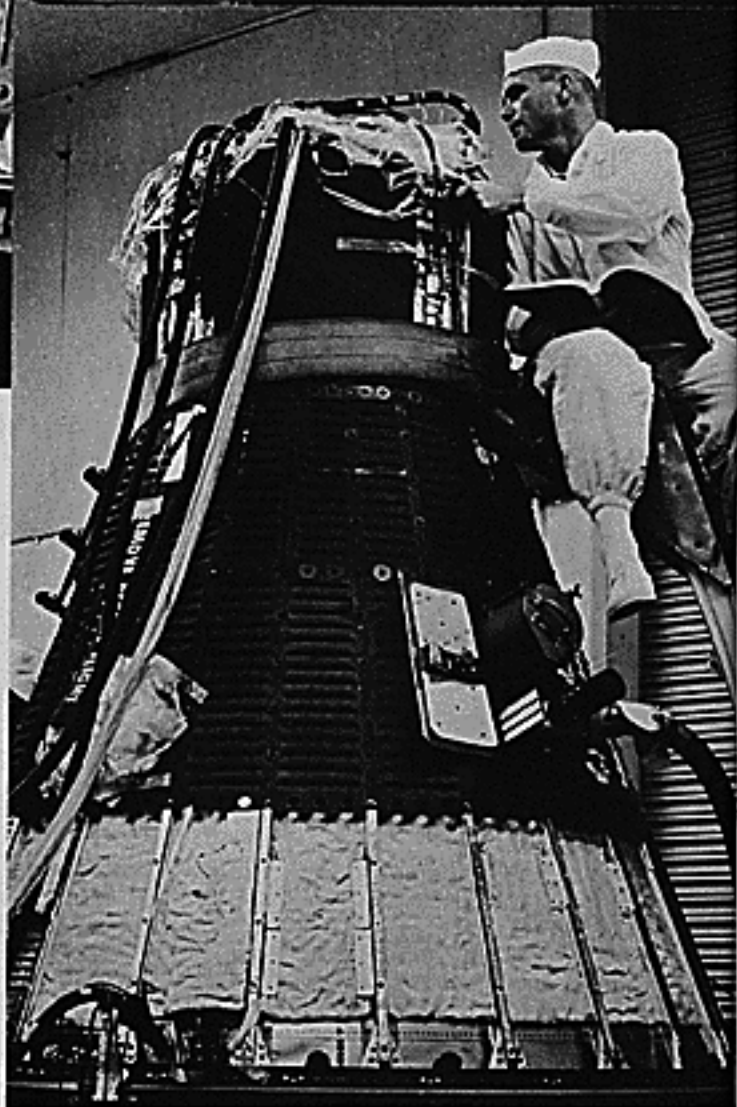






ADDITIONAL "WHITE ROOM" photos indicate the scope of activities there by an astronaut prior to a Mercury mission. Plastic boots or white tennis shoes and white clothing are required in the room which is electronically dust filtered, humidity controlled, and air-conditioned. Glenn is shown above listening to the results of a systems check, and, at the right, he checks the equipment at the top of the spacecraft, which has a protective covering. The spacecraft system checks are conducted in the White Room by McDonnell technicians, NASA engineers, and the astronauts.

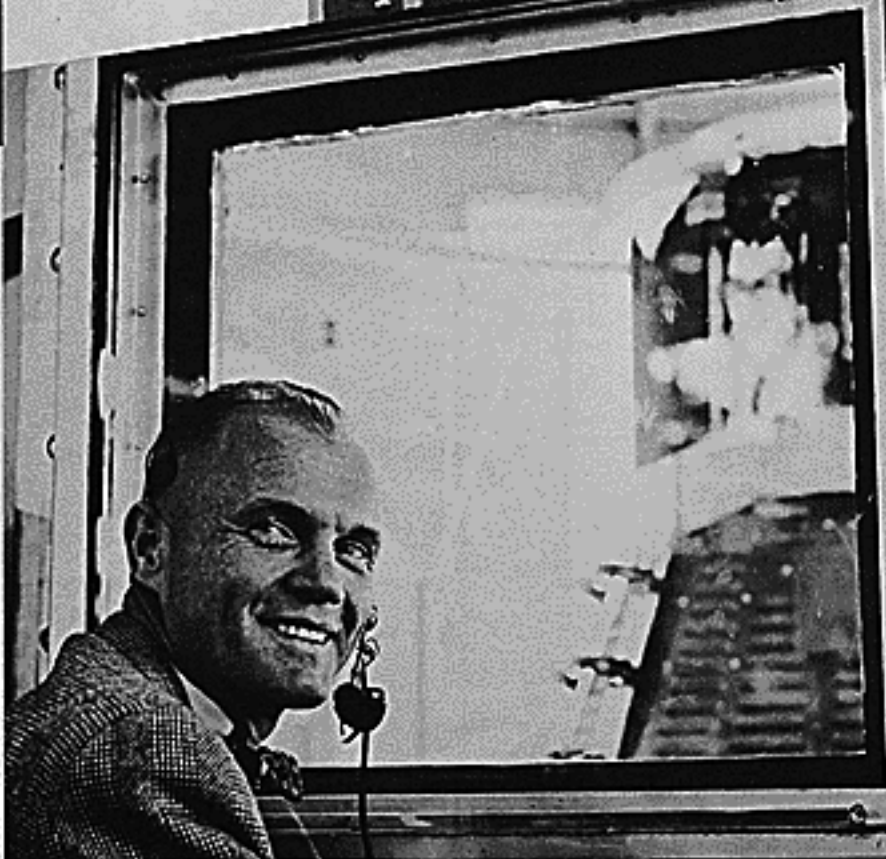
On the right-hand page, Glenn is shown at the top inside the Mercury spacecraft as he performs the necessary checks and rechecks on the many complicated systems of the Friendship 7 spacecraft. At bottom left, he discusses the results of the test with McDonnell technicians as he seems pleased with the results. The picture at the lower right depicts him poring over the results of the test to make certain that all systems register "go" and to doublecheck that previous observations of all parties have been correctly coordinated.

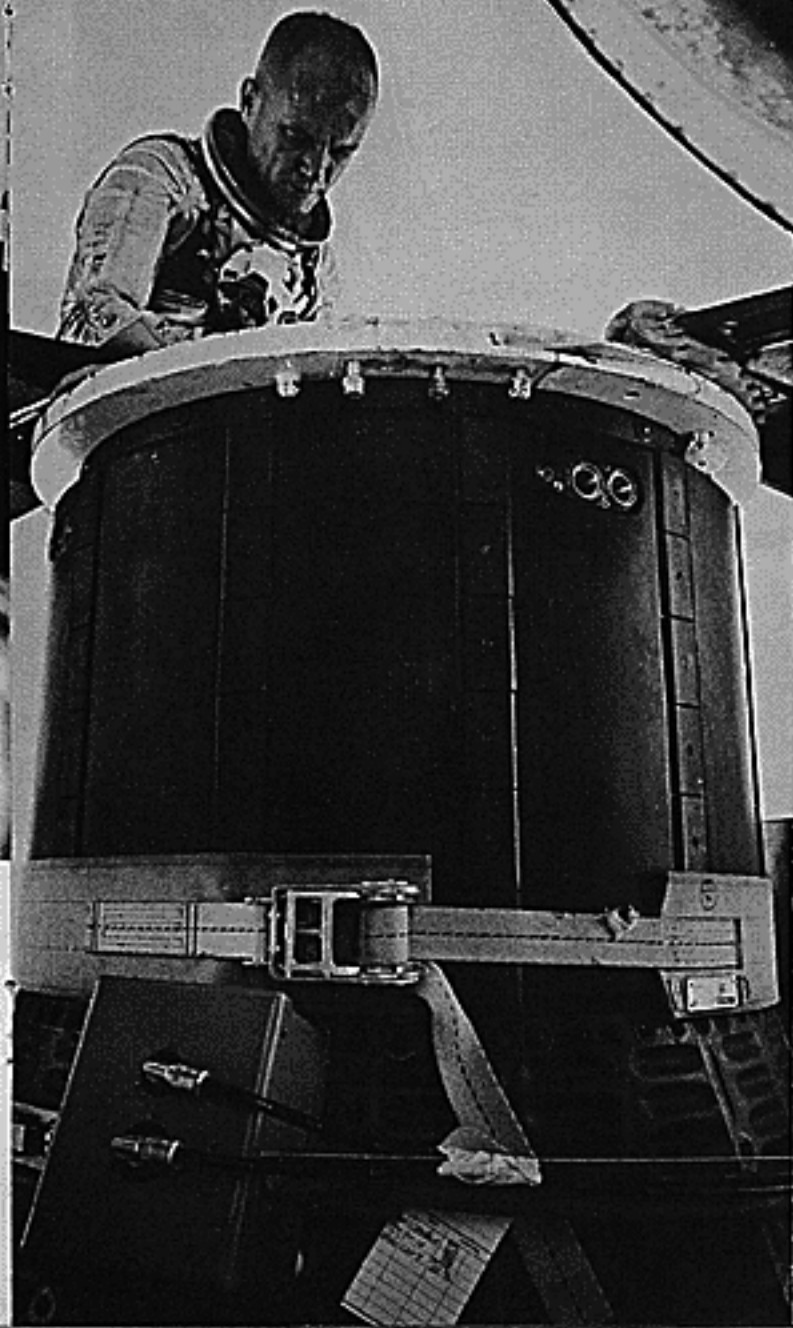
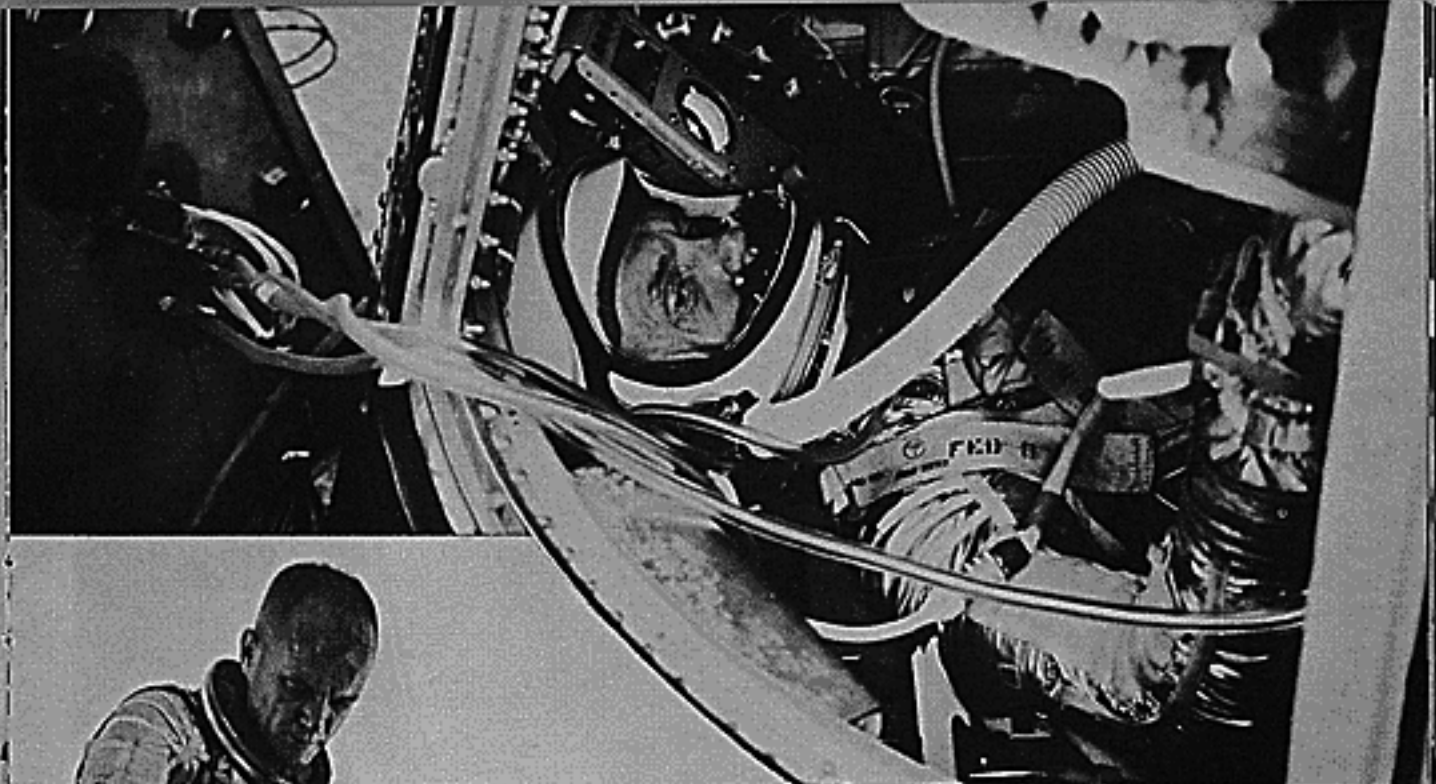


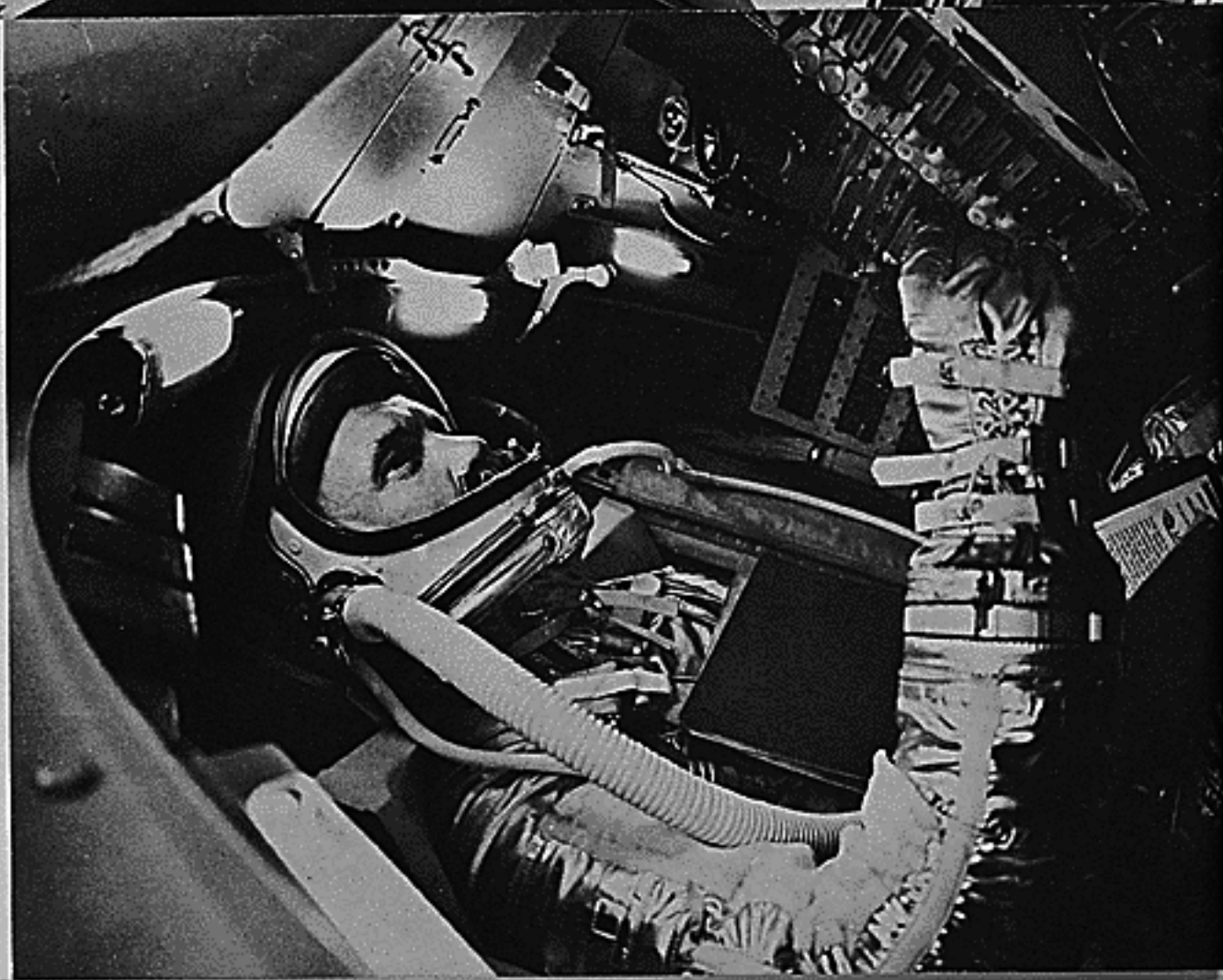
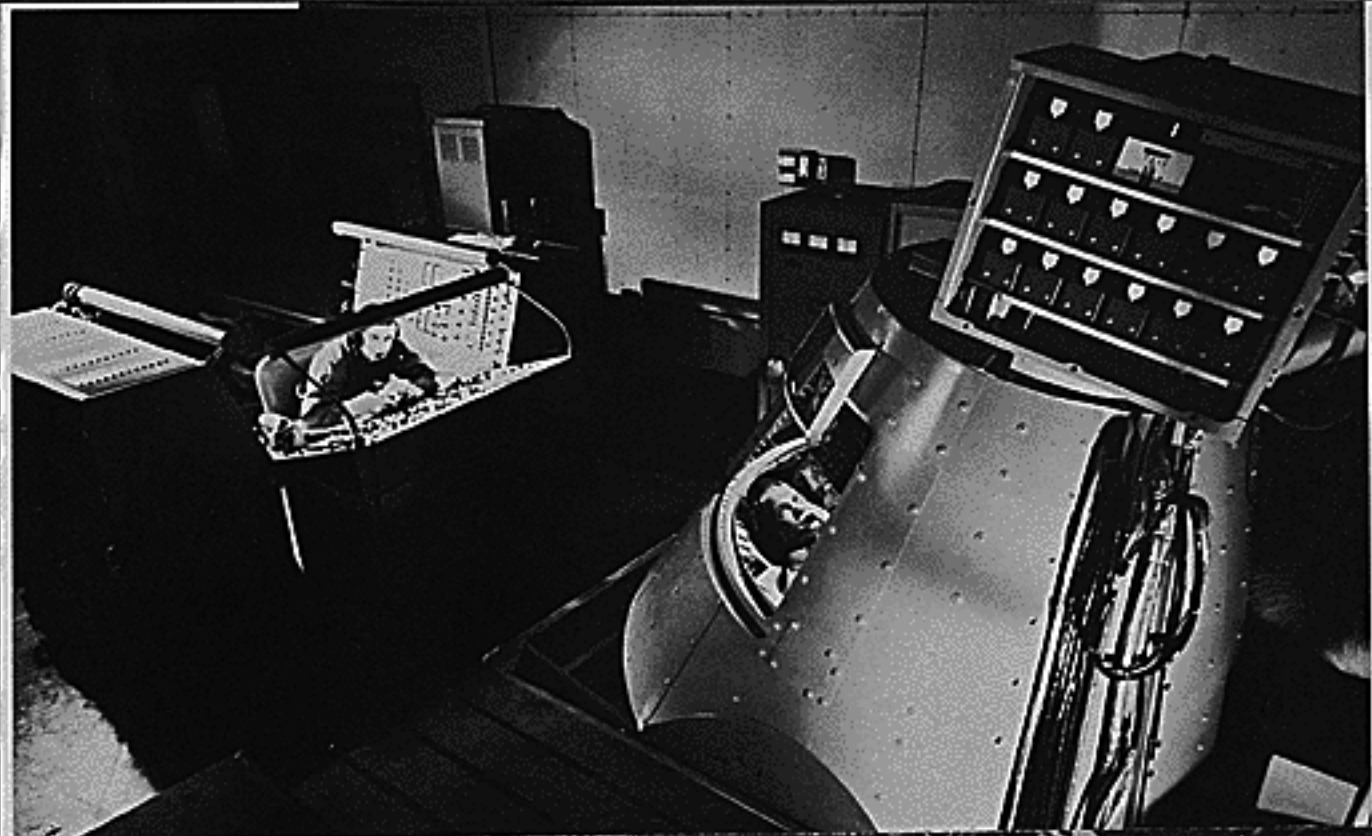




Glenn is shown outside the altitude chamber prior to going into it later for an extended environmental control system checkout and verification of the flight worthiness of the spacecraft in a high-altitude environment. The massive pumps can produce the effect of a flight to 120,000 feet by removing almost every molecule of air from the chamber. On the page at the right, Glenn is pictured in the spacecraft in the altitude chamber, egressing from the altitude chamber at lower left, and leaving the chamber.

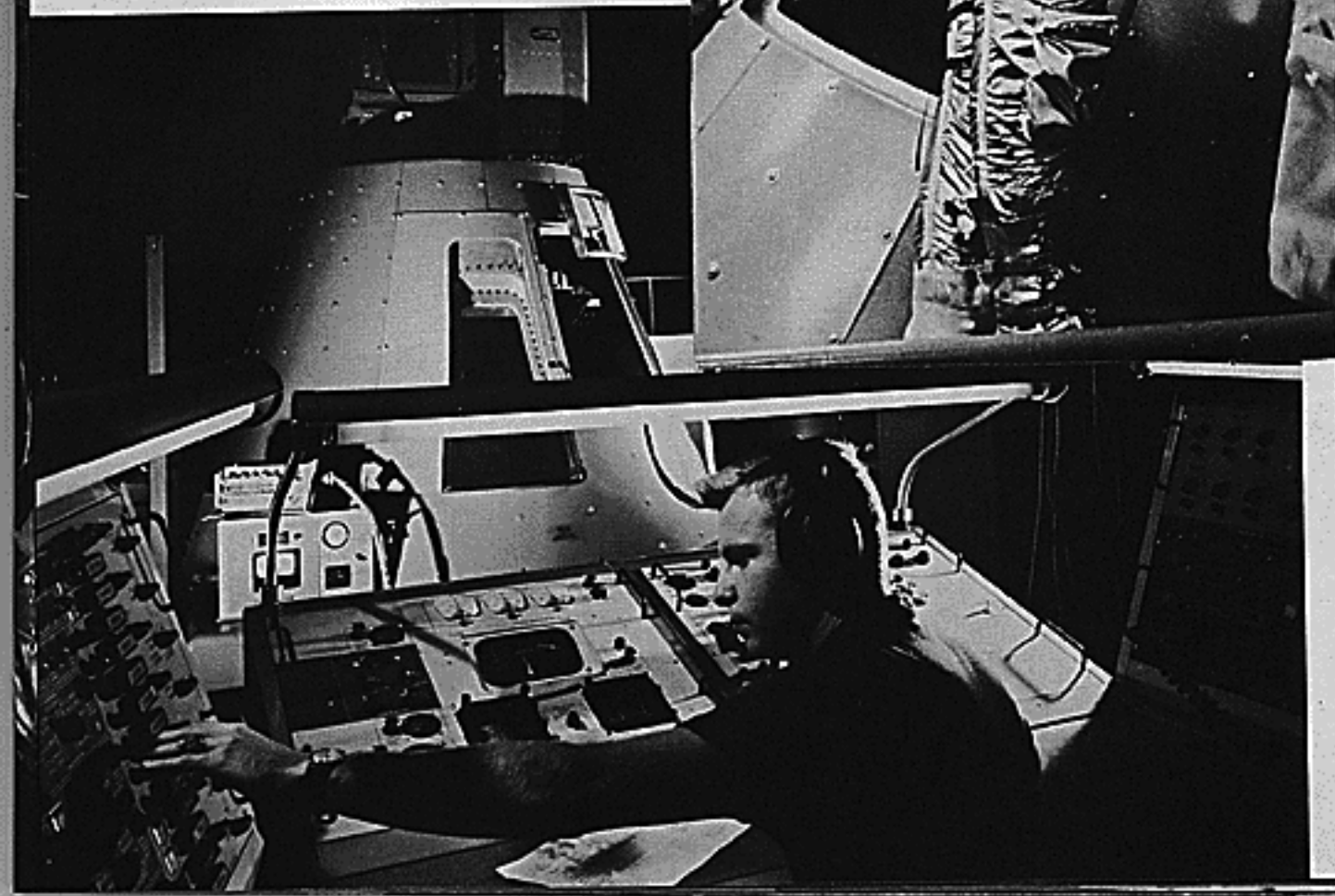
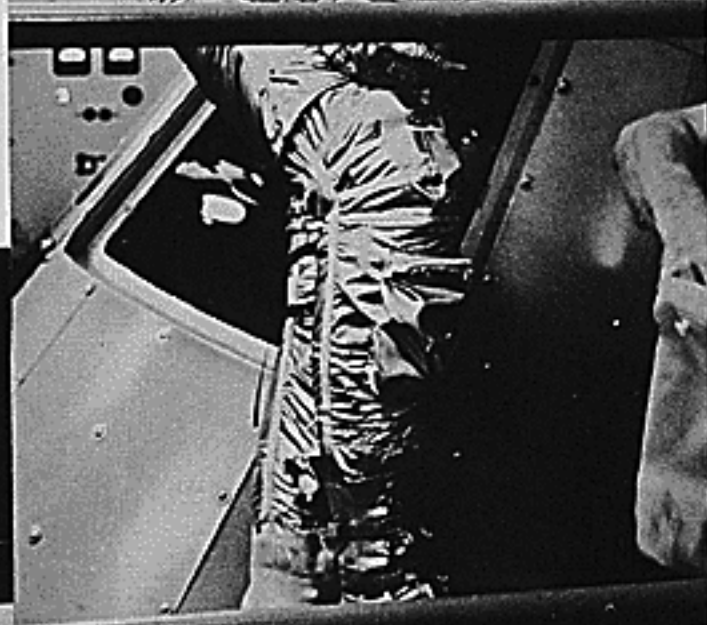


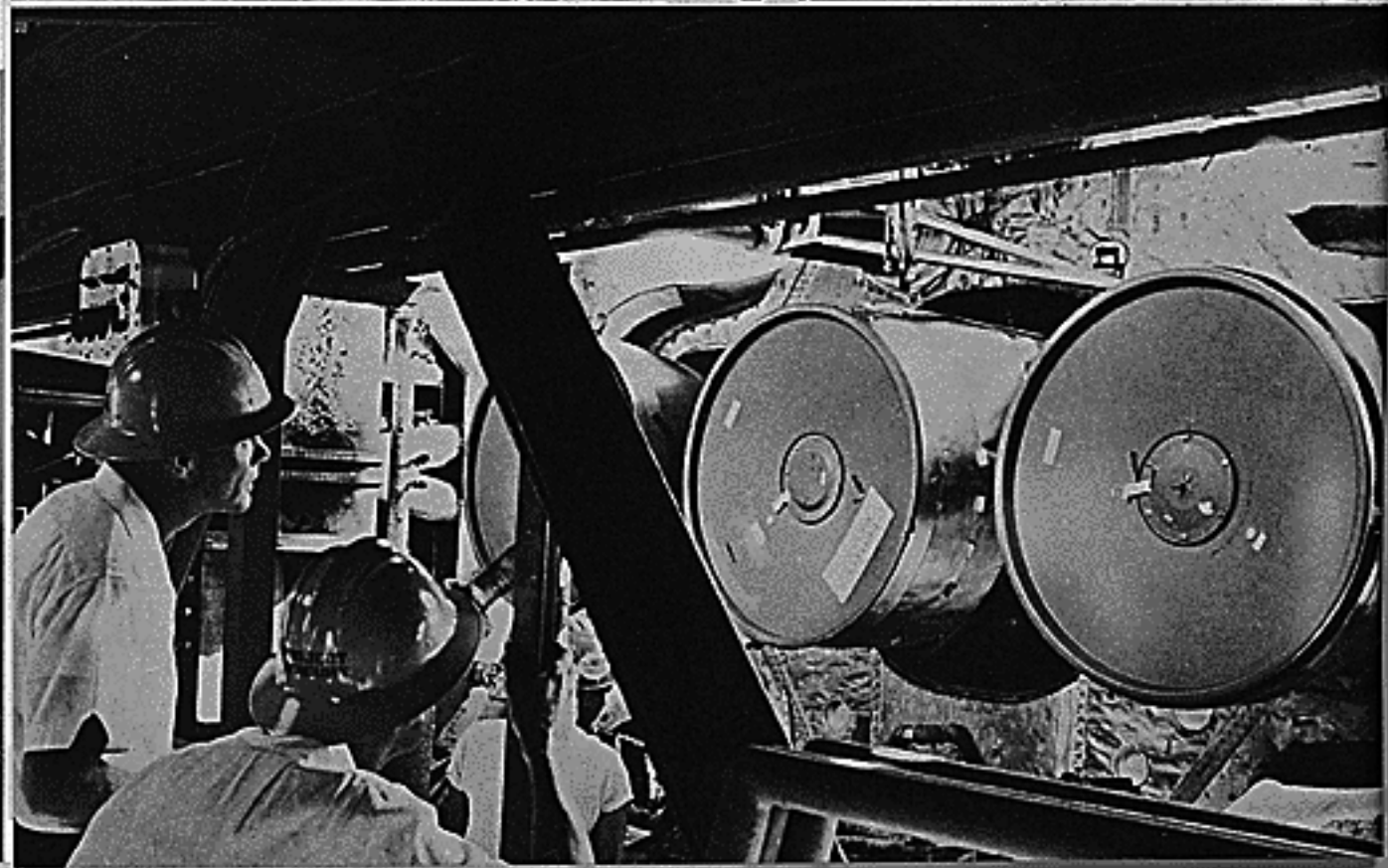
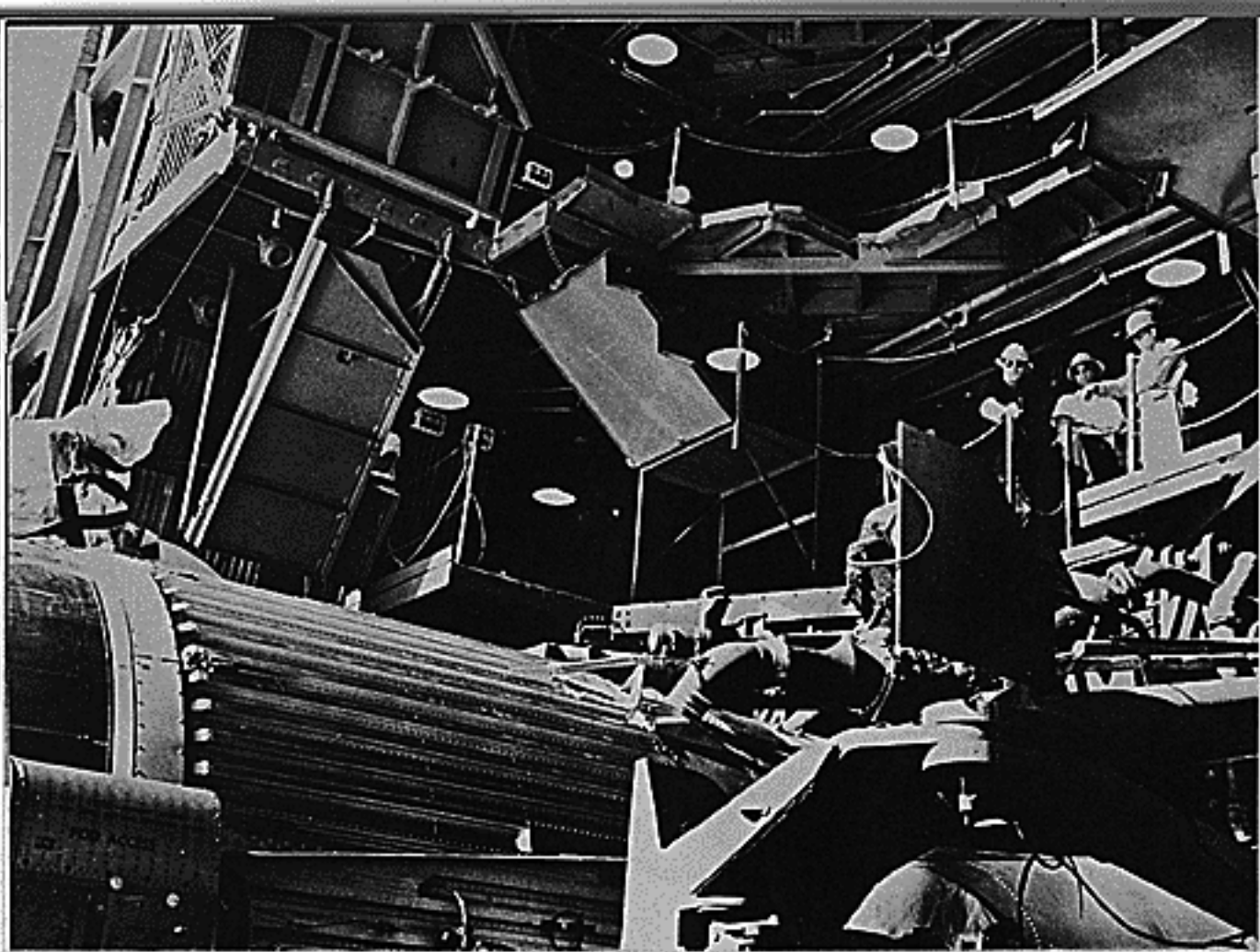


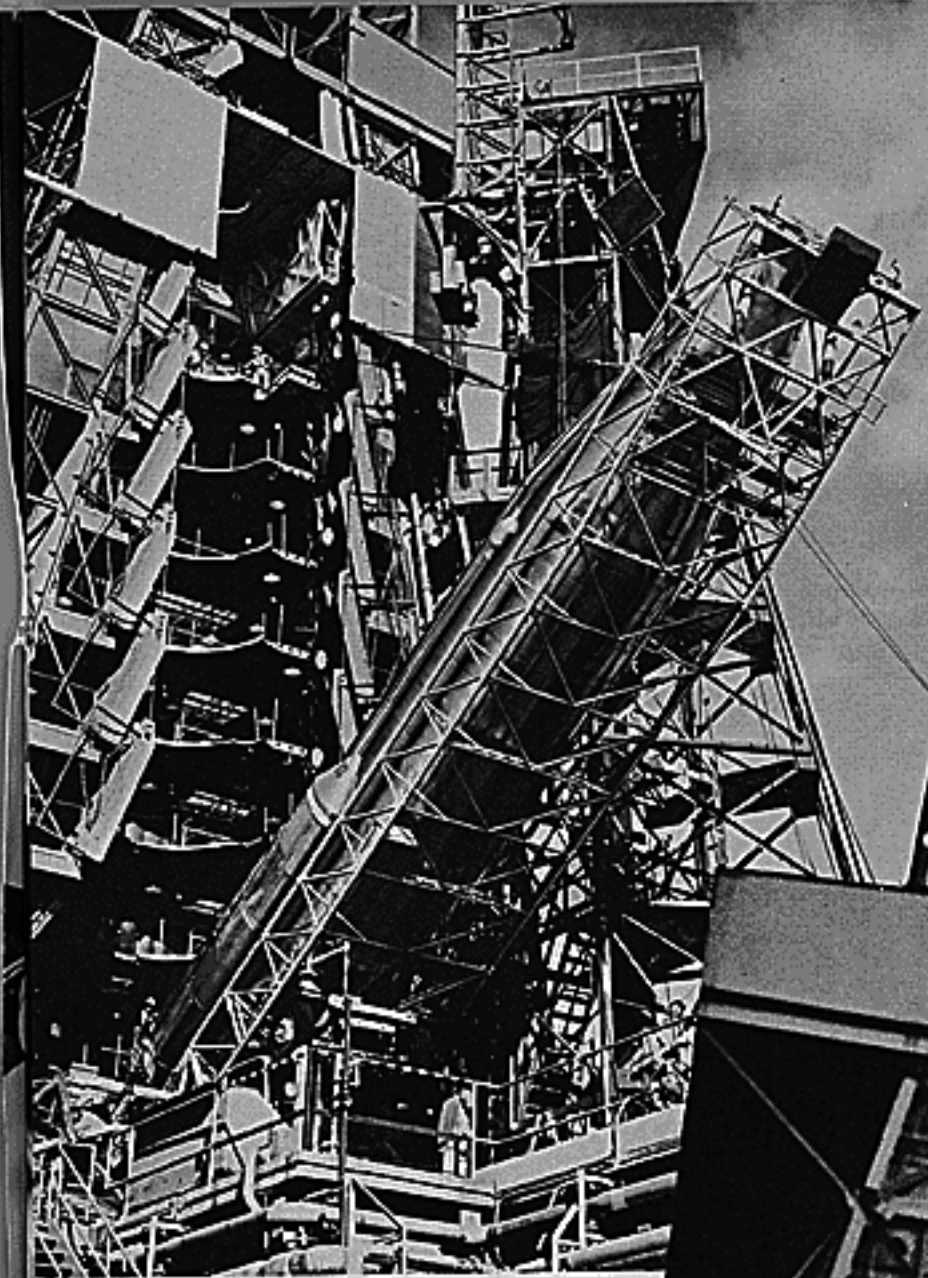


One of the most frequent tests run by Project Mercury astronauts during prelaunch training is in the procedures trainers at Langley AFB and at the Mercury Control Center at Cape Canaveral. At the top of the page at the left, Glenn is shown in the Langley procedures trainer with Jim Prim at the console, monitoring the simulated flight. The lower picture at the left shows Astronaut Glenn, suited up, during a full-flight simulation test in the trainer located in the Mercury Control Center (this close-up shot gives a good view of the interior of the Mercury spacecraft as the astronaut goes about his many assigned tasks during a full-scale simulated flight).

Below is an excellent picture of the procedures trainer at the Cape with Charles Olasky of Flight Simulation Branch, Flight Operations Division, at the console, offering an unusual view of the complexity of the consoles which are used not only in training but also during actual flight operations. At the right, John Glenn is shown leaving the side hatch of the spacecraft after completing the strenuous preflight tests - smiling as usual at the completion of a hard day's work. This test, like all others in the Project Mercury program, has provided the astronauts with a training vehicle which has proved valid during a testing period. As usual, John Glenn flashes his now famous smile indicating that everything is A-O-K.



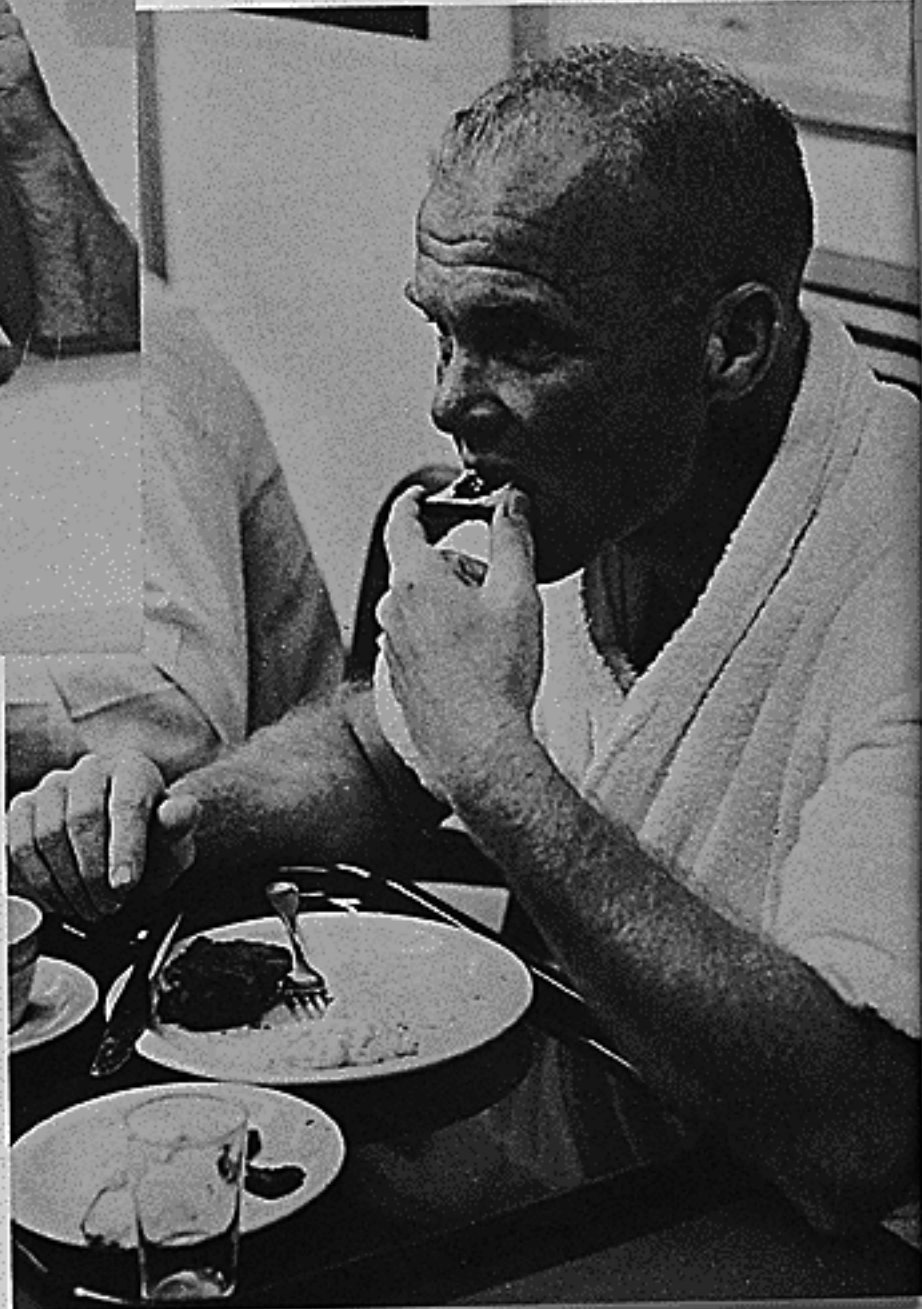
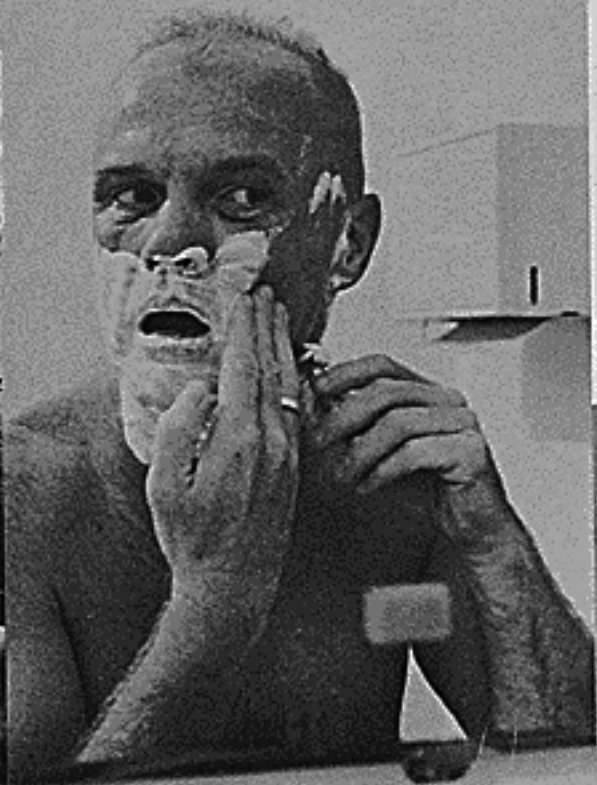


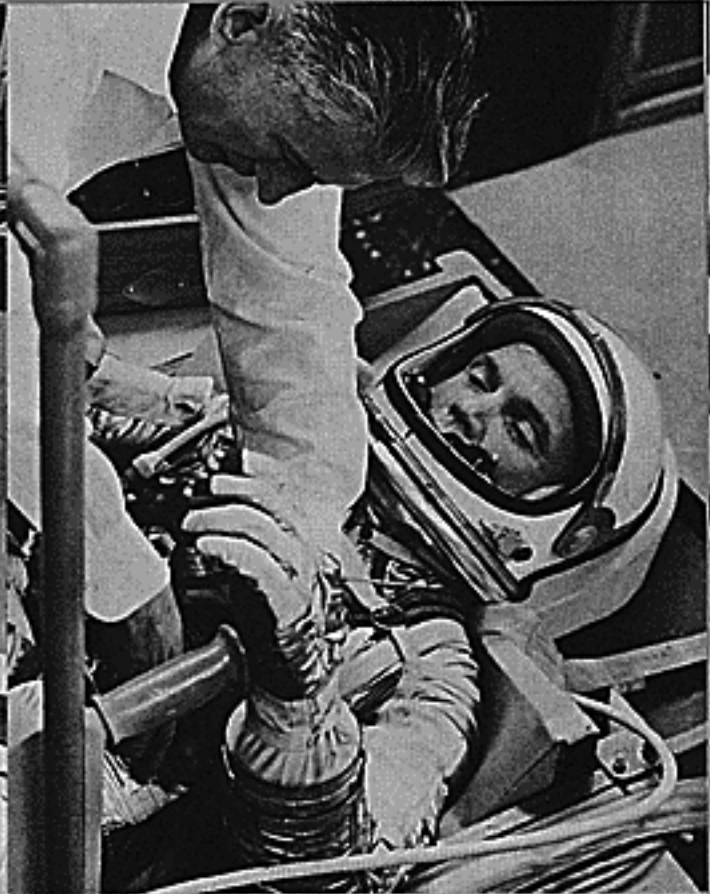


THE LAUNCH VEHICLE ERECTION is a matter of prime importance to the mission pilot and the back-up pilot. At the top, on the page at the left, Glenn and Carpenter stand on the gantry at Complex 14 and observe as the huge booster is wheeled into position. At the bottom the two astronauts get a closer look at the huge rockets which were later to propel Glenn into orbit. At the left, the Atlas 109D is shown as it is being raised into position and, below, Glenn - looking more like a structural engineer than an astronaut - seems to gaze into the future.



John Glenn shaves prior to "taking a little trip," and follows that daily routine with the low residue breakfast of filet, eggs, toast, jelly, postum, and orange juice. At right, left, he starts to don the togs for his trip as suit technician Joe Schmitt lays out the many components of the astronaut's suit. After being dressed, Glenn was helped into the pressure-testing rig, and his suit was tested a final time to insure that there were no leaks which might lead to difficulties during the flight. At lower right, Glenn is shown after the completion of suiting and the pressure check, waving goodbye to Walter C. Williams, Associate Director of Manned Spacecraft Center and Astronaut Donald K. "Deke" Slayton, who has been named as pilot for the next three-orbit flight on the Mercury-Atlas 7 mission which has been tentatively planned to be made during May or June of this year.



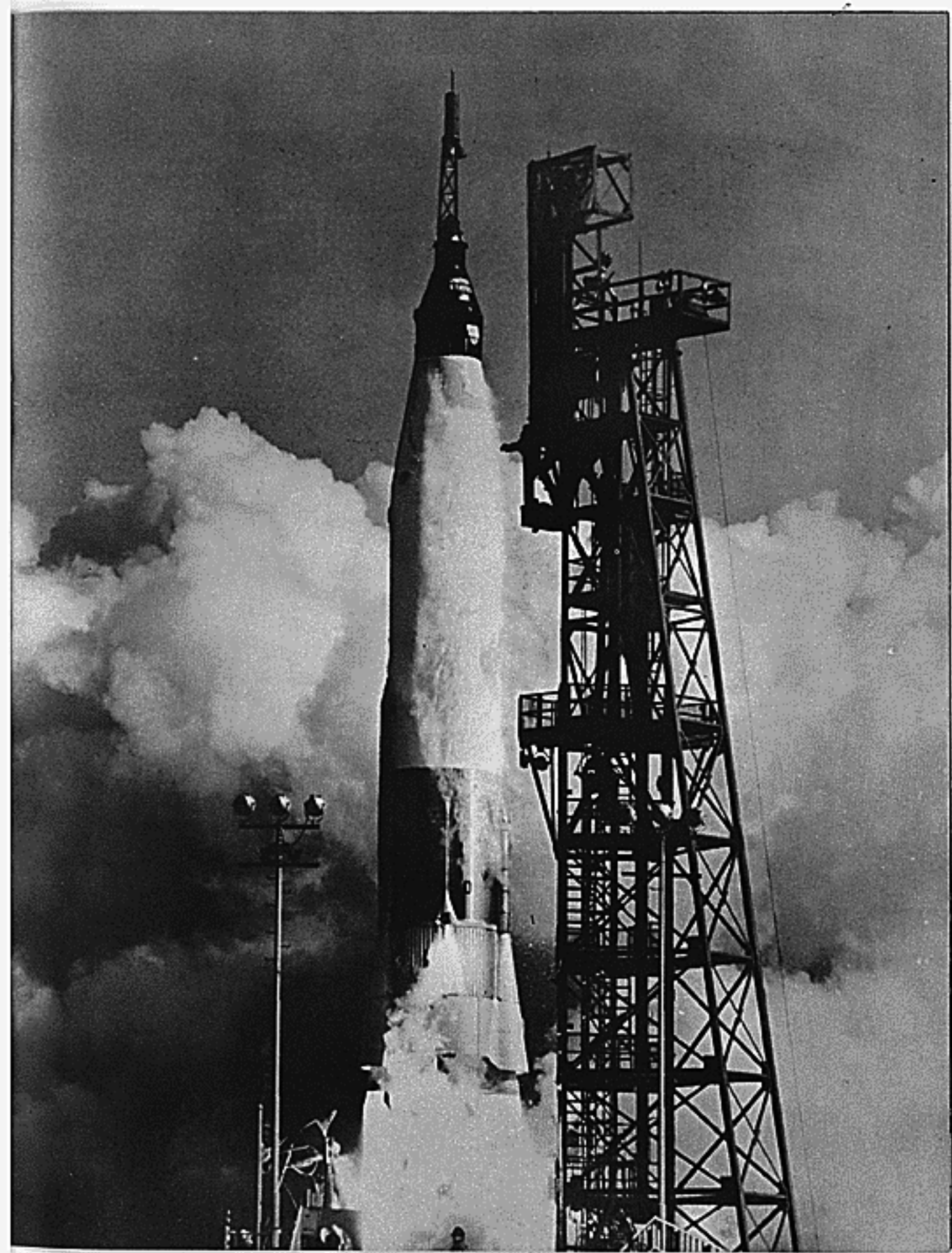




On February 20, 1962, Astronaut John Glenn departed from Hangar S with Joe Schmitt and Dr. William Douglas, entered the transfer van and was transported to Launch Complex 14. It was from that pad, almost 5 hours later, that he was launched into space and subsequently orbited the earth three times. This was a culmination of a long period of intensive preparation for the history-making flight. Below, he is shown entering his now famous Friendship 7 spacecraft and started his prelaunch check-out activities.

At the right is the lift-off of the Mercury-Atlas 6 as it carried Astronaut John Glenn on his journey into space - the first American to orbit the earth - the first known space traveler to pilot his spacecraft through the space beyond the atmosphere. After circling the earth three times in 4 hours and 56 minutes from lift-off to touchdown at speeds averaging 17,500 miles per hour, he returned to earth and subsequently was acknowledged by millions of admirers as he made a limited tour to accept the plaudits of the crowds in a series of celebrations.





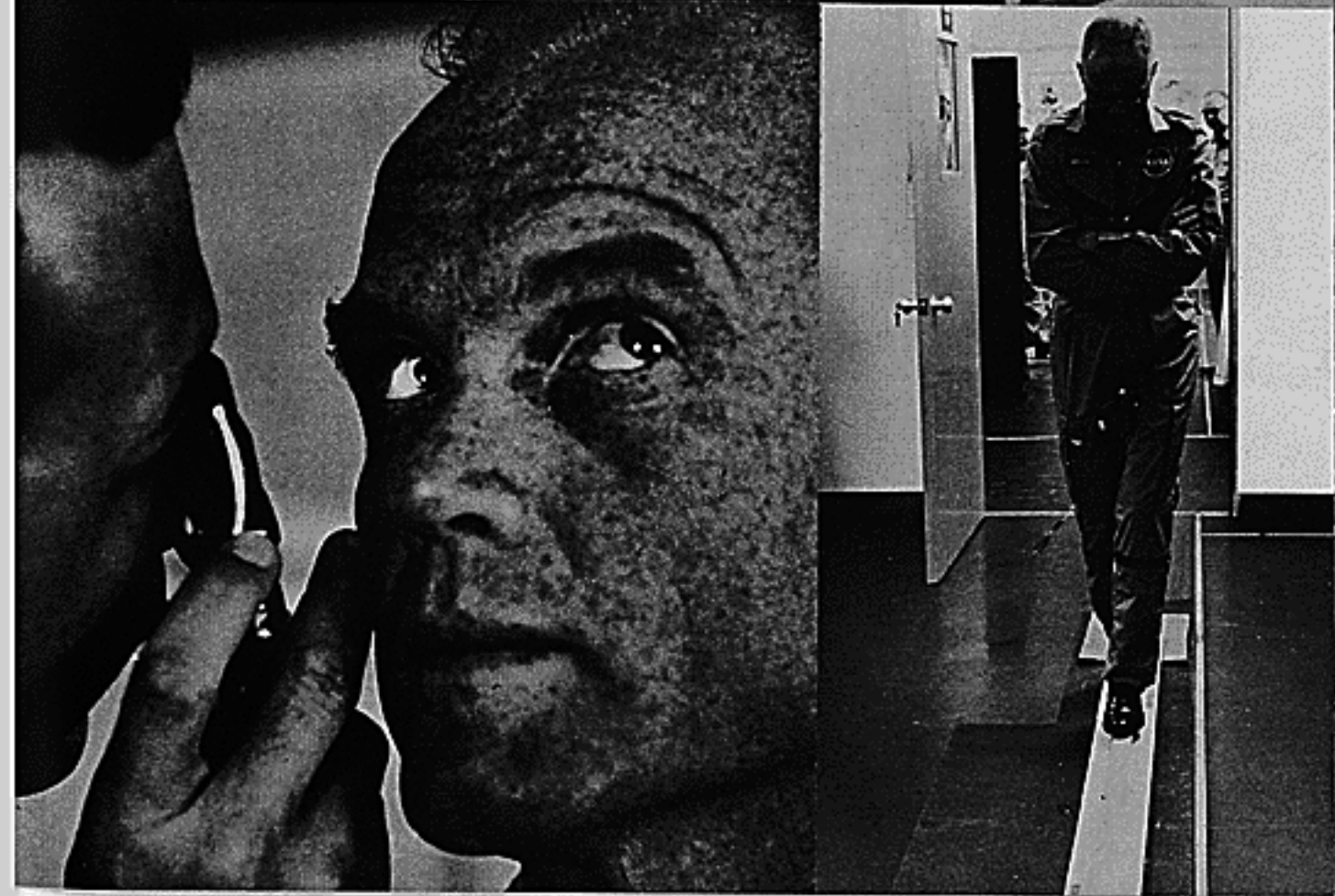


Following his eventful journey and recovered by the USS Noa, he was given a hearty welcome at Grand Turk Island by Astronauts M. Scott Carpenter and Deke Slayton, and Public Affairs Officer John Powers. Below six members of the famous astronaut team get together at Grand Turk. Left to right: Carpenter, Slayton, Glenn, Gus Grissom, Alan Shepard, and Walter Schirra. Gordon Cooper, the seventh astronaut, was in Australia at the time making his report on the mission. The page at the right shows three phases of the debriefing activity at Grand Turk. These were but a few of the tests administered to Glenn following his orbital flight.

WELCOME

COL. JOHN GLENN





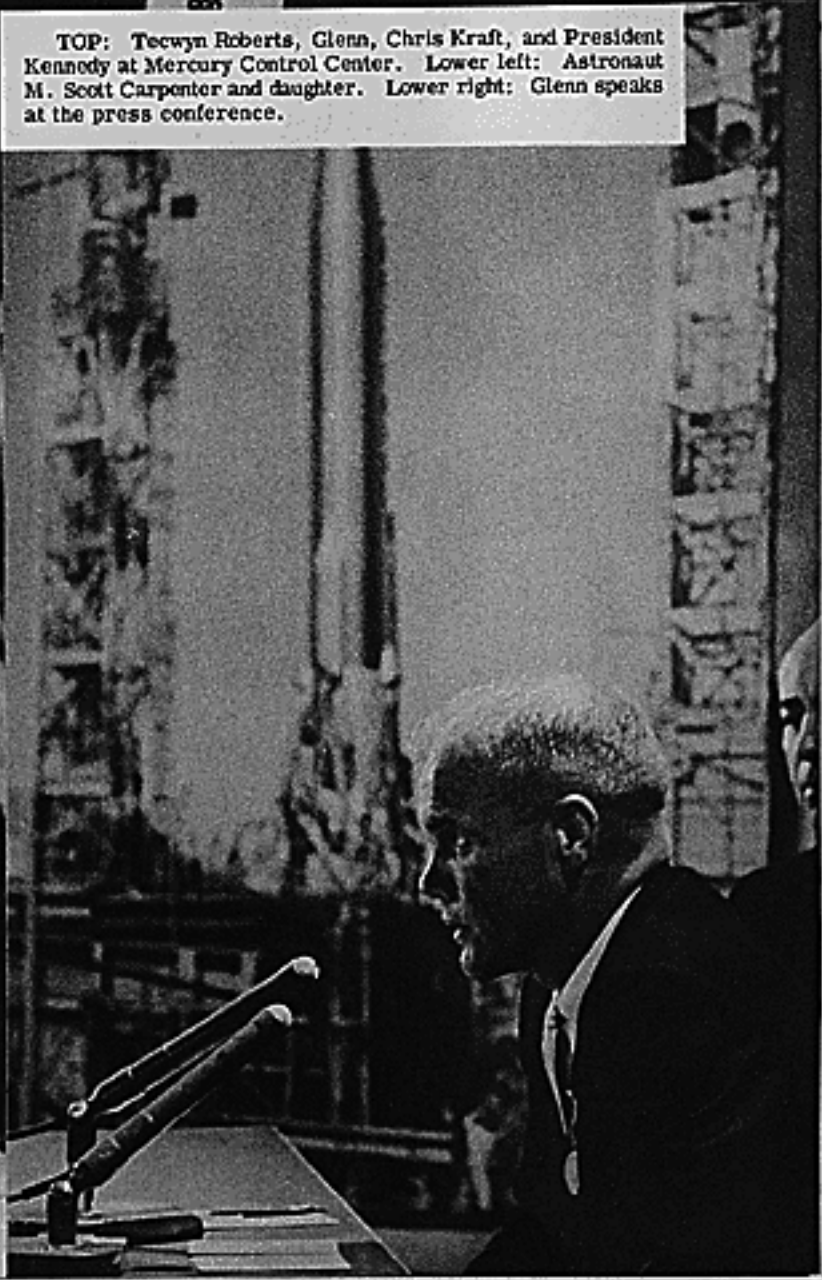




A JOYOUS GROUP at Patrick AFB as Astronaut John Glenn returned to his homeland. Shown on the left-hand page, top, is David, Lynn, John, Jr., Annie, Mrs. John Glenn, Sr., and John Glenn, Sr., with Vice President Lyndon B. Johnson. Below, the parade starts with Glenn riding between the President and Maj. Gen. Leighton Davis. At the top, part of the crowd which gathered outside of Hangar S to hear the President and others speak. Above, President Kennedy addresses the crowd with Astronauts Alan B. Shepard, Jr., and Virgil I. "Gus" Grissom at the left and Manned Spacecraft Center Director Robert R. Gilruth at the right. At the left, Glenn is shown outside Hangar S with Marine Lt. Col. Thomas Miller, his Arlington, Virginia, neighbor and President Kennedy. While at Cape Canaveral, the President toured Mercury Control Center and the Launch Pad 14 area and presented the NASA Distinguished Service Medal to Glenn and to Gilruth.



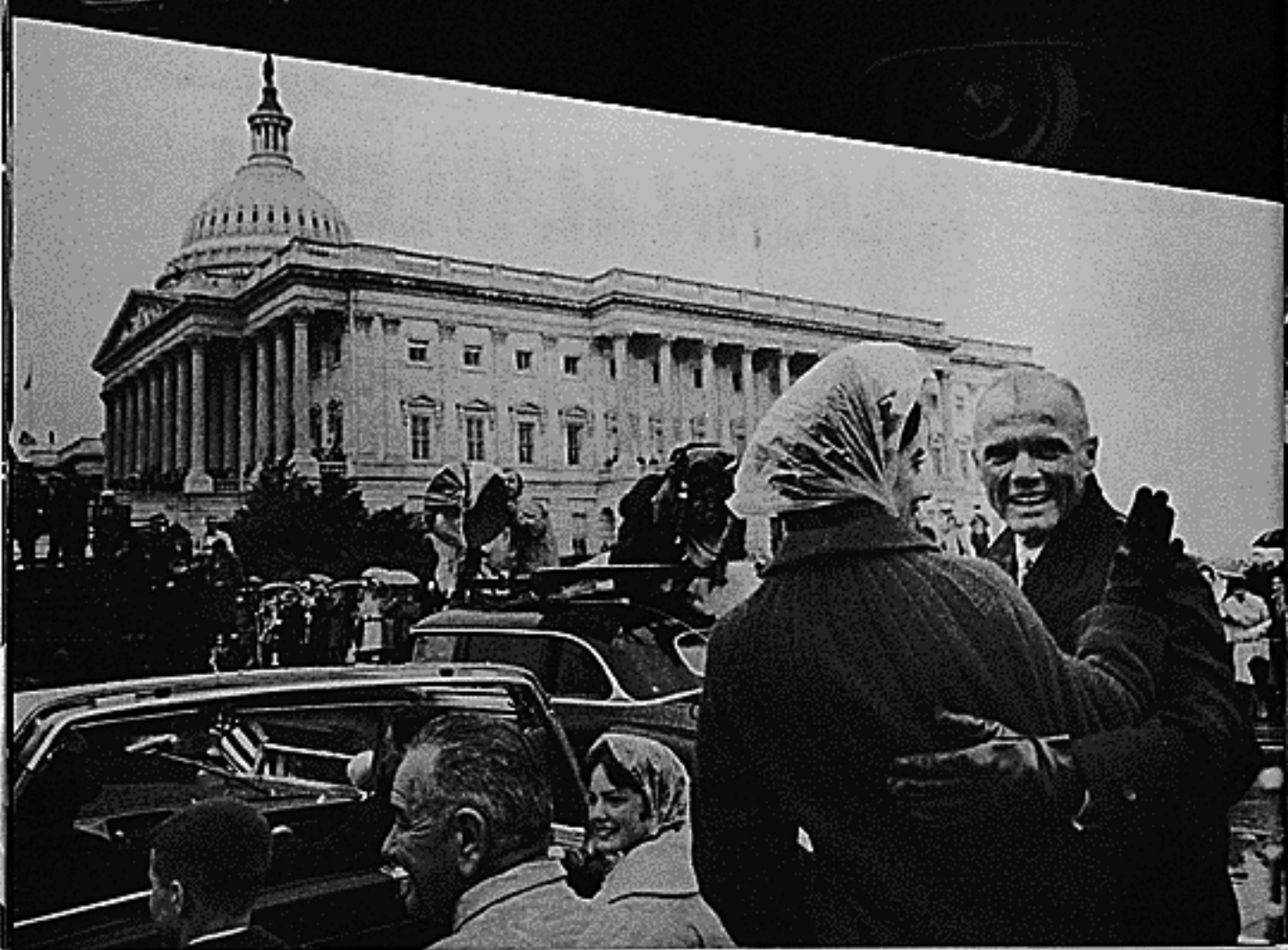
TOP: Tecwyn Roberts, Glenn, Chris Kraft, and President Kennedy at Mercury Control Center. Lower left: Astronaut M. Scott Carpenter and daughter. Lower right: Glenn speaks at the press conference.

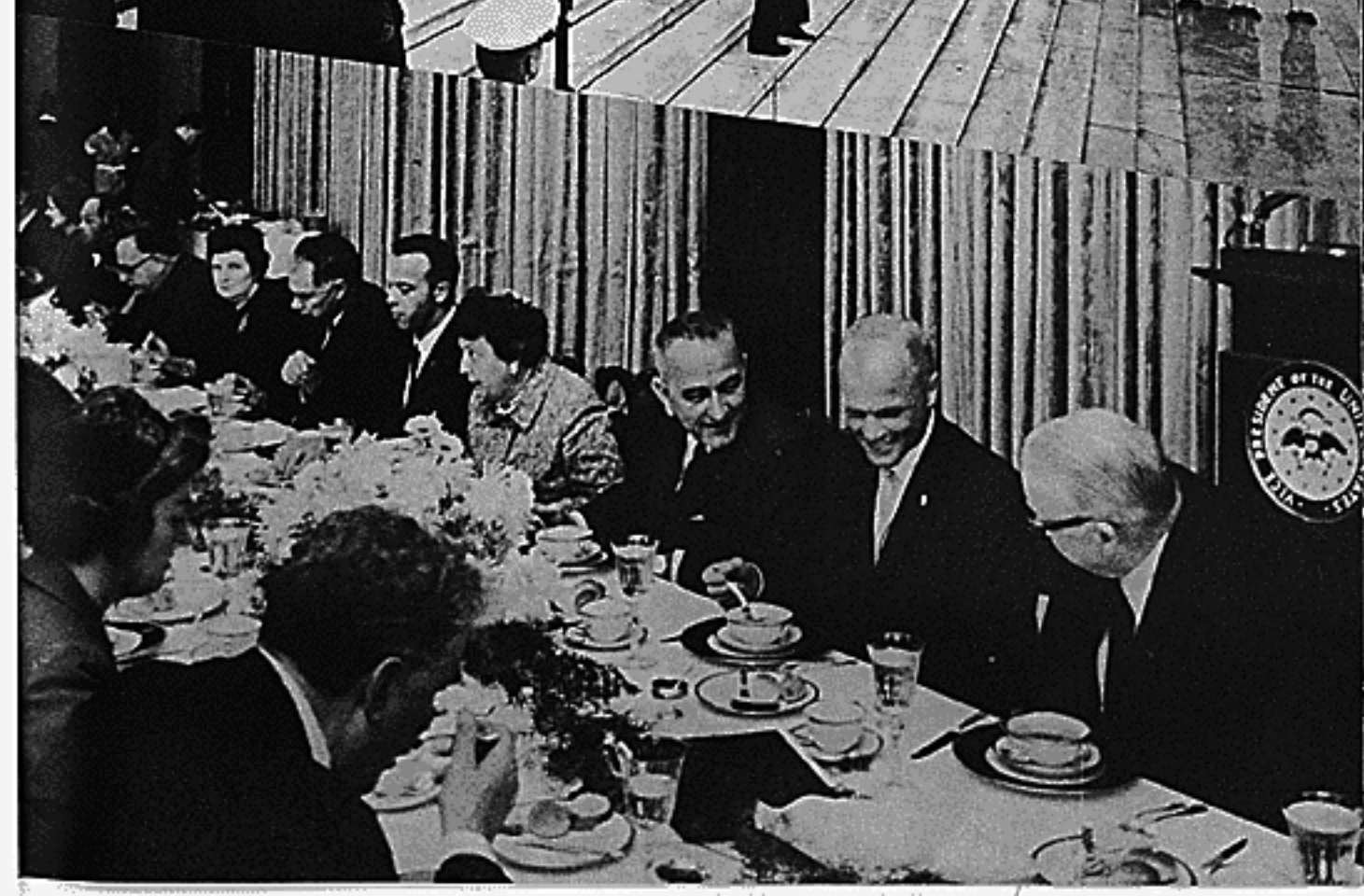




Well done! **ASTRONAUT JOHN H. GLENN, Jr.**









THE NEW YORK SKYLINE nears and confetti starts to fall. Below is a small portion of the crowd which lined the streets to get a glimpse of John Glenn.





ANOTHER SCENE which indicates the size of the New York crowd which turned out to see Glenn. At lower left, Glenn stands at City Hall, flanked by Mayor Robert Wagner and Vice President Lyndon Johnson. At lower right, Astronauts Alan Shepard and Gus Grissom return the waves of the crowd.





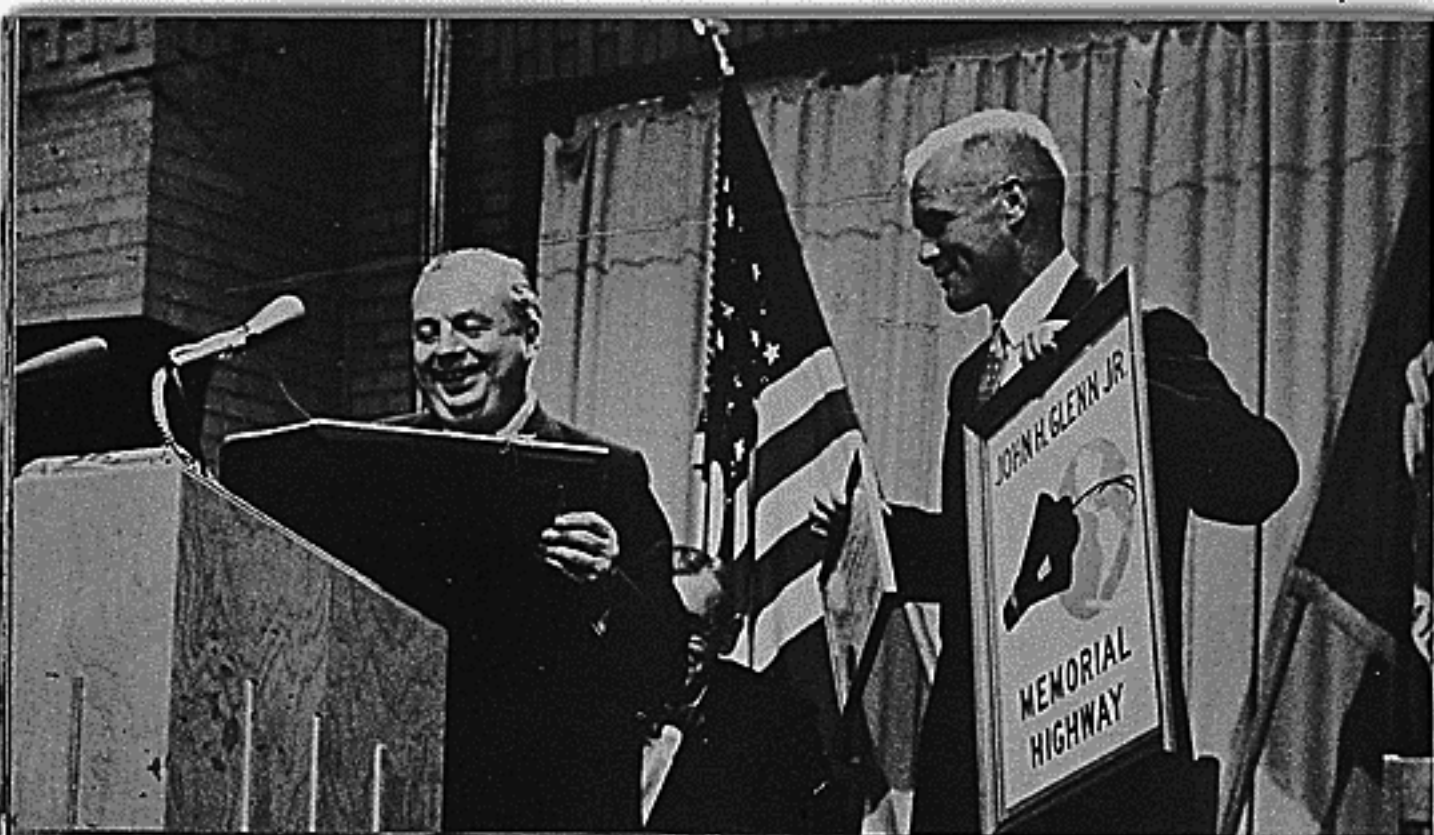
Below: AT THE UNITED NATIONS
 Upper right: MEETING GENERAL MAC ARTHUR
 Lower right: LYNN AND THE SKYLINE



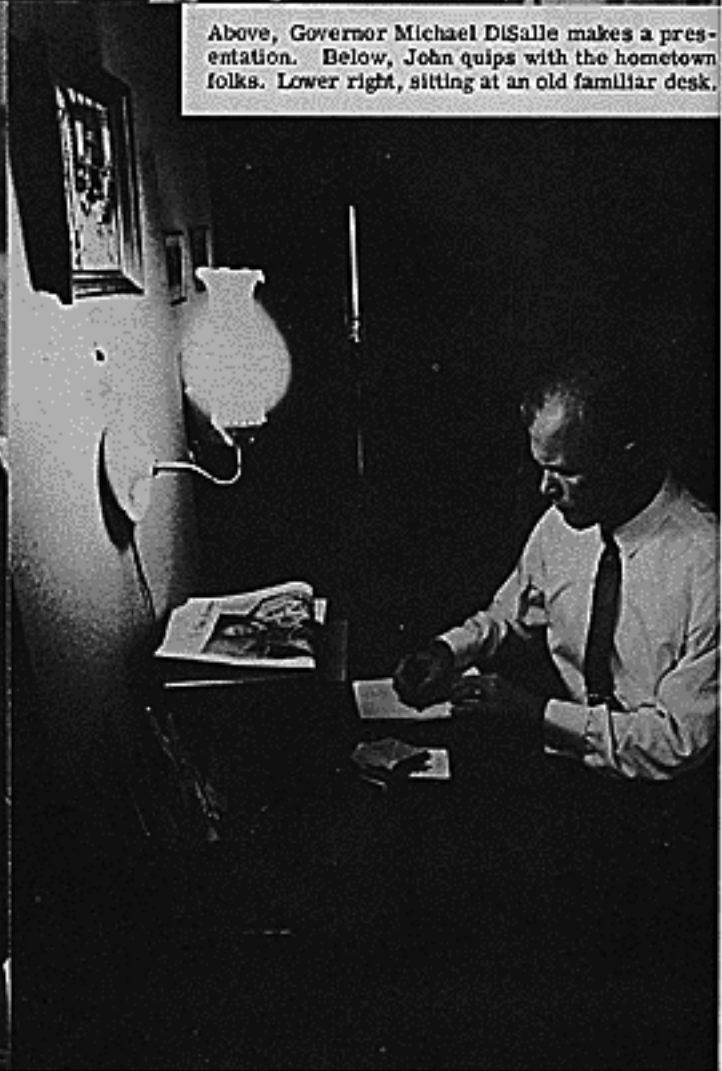


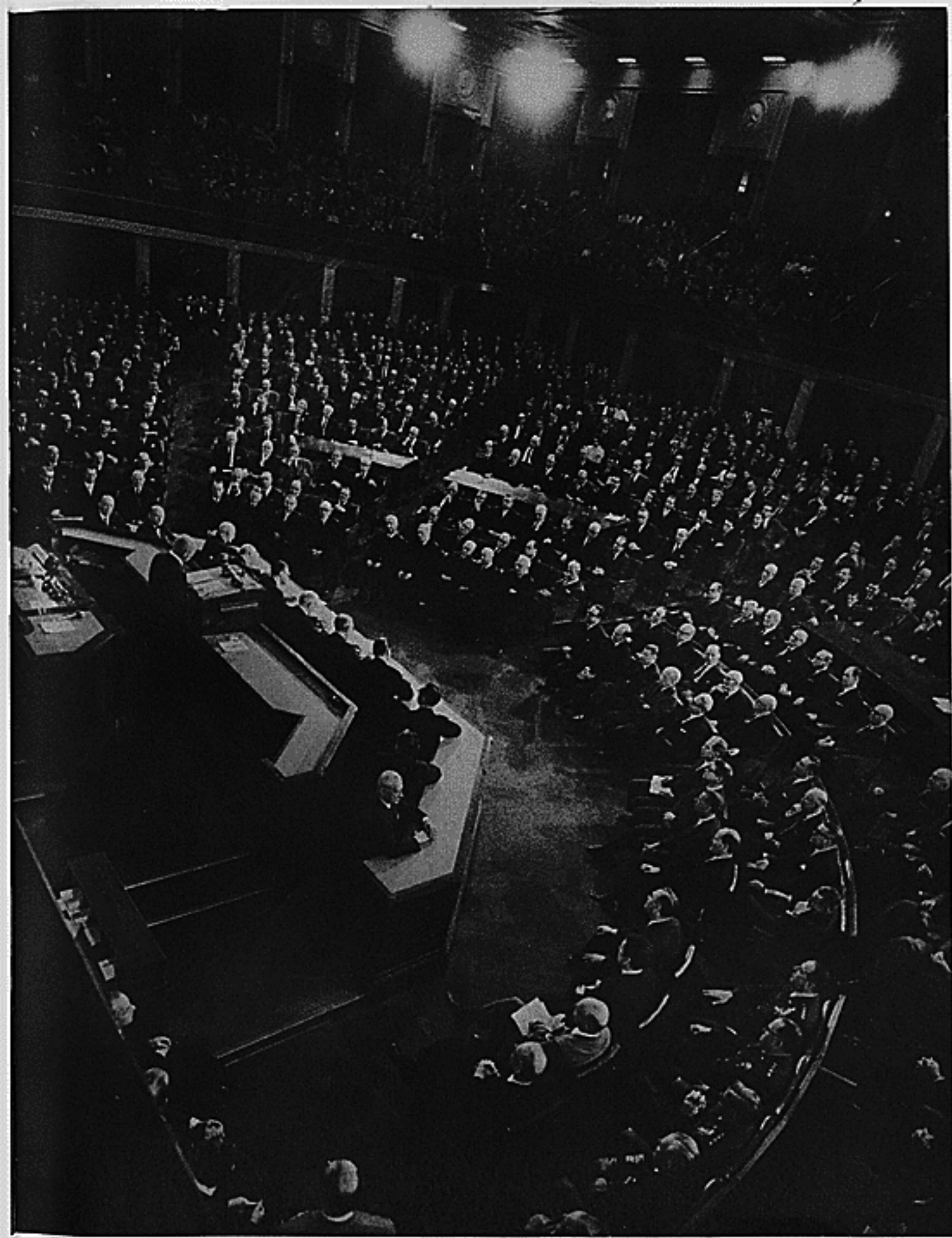
NEW CONCORD, OHIO, MARCH 3, 1962





Above, Governor Michael DiSalle makes a presentation. Below, John quips with the hometown folks. Lower right, sitting at an old familiar desk.







NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, D. C. 20546

FACT SHEET

ASTRONAUT GLENN'S SPACE MISSION

February 20, 1962

The Mercury Atlas VI mission with the spacecraft, Friendship 7, piloted by Astronaut John H. Glenn, Jr., lifted off the launching pad at Cape Canaveral (now Cape Kennedy), Florida at 9:48 a.m. February 20, 1962. The 260,000-pound Atlas launch vehicle placed the spacecraft in orbit after 5 minutes, 3 seconds of powered flight.

The elliptical orbit had a perigee of (low point) 100.3 statute miles (161.3 kilometers), apogee (high point) of 162 miles (261 kilometers). The spacecraft completed an orbit every 88.2 minutes, in a path which formed a 32.5-degree angle with the equator.

During the third orbit, the spacecraft's retrorockets were fired, slowing the craft to a speed which would allow the Earth's gravity to pull it down for a landing after completing that orbit.

Parachuting down, Friendship 7 splashed in the Atlantic at 2:43 p.m. about 166 miles (270 kilometers) east of Grand Turk Island and was recovered by the Destroyer, USS NOA.

WORD ONE/KEYSEARCH

D:02-20-62 HQS N:00 KMER

-End-

Astronaut Glenns HQS
Space Mission

9/20/65

R20012



NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
400 MARYLAND AVENUE, SW, WASHINGTON 25, D.C.
TELEPHONES: WORTH 2-4155—WORTH 3-1110

FOR RELEASE: Sunday a.m.'s
January 21, 1962

Release No. 62-8

MERCURY-ATLAS 6 AT A GLANCE

MISSION -- Manned orbital flight to (1) evaluate the performance of a man-spacecraft system; (2) investigate man's capabilities in the space environment; (3) obtain the pilot's opinions on the operational suitability of the spacecraft and supporting systems for manned space flight.

LAUNCH DATE -- The flight currently is scheduled no earlier than January 24, 1962. On whatever day, the launch will be attempted between 7:30 a.m. and 12:30 p.m. and may "slip" on a day-to-day basis as required. Launch timing will be planned to provide at least three hours of daylight search time in the probable recovery areas.

FLIGHT DURATION -- Depending on literally thousands of variables, the Mercury Operations Director (Manned Spacecraft Center Associate Director Walter C. Williams) may elect a one, two or three-orbit mission. That decision will be made only minutes before launch and may be changed at any time during the mission. Recovery after one full orbit is planned for about 500 miles east of Bermuda; after two orbits, some 500 miles south of Bermuda; three orbits, about 800 miles southeast of Cape Canaveral, Fla. Each orbit takes about 90 minutes, carrying the craft between 100 and 150 miles altitude, 32 degrees north and south of the equator.

If the mission ends after orbit one or two, the astronaut will be moved to the Kindley Air Force Base Hospital in Bermuda for a 48-hour rest and debriefing. If the mission goes a full three orbits, he will be flown to Grand Turk Island (Bahamas) for a similar operation before being returned to the mainland.

1-1

WORD ONE/KEYSEARCH

D:01-21-62 PAO N:62-8 G MER Mercury Atlas 6 PAO R20012
At a Glance
MA-6 Overview

PILOT -- Astronaut John H. Glenn, Jr., 40. A lieutenant colonel in the United States Marine Corps, Glenn has been with NASA for three years on a detached duty basis. Backup pilot for this flight is Astronaut M. Scott Carpenter, 36. (See biographies).

SPACECRAFT -- Bell-shaped, the MA-6 craft -- listed as No. 13 in engineering documents and named "Friendship 7" by Astronaut Glenn -- stands 9½ feet high and measures 6 feet across the base. Spacecraft weight at launch will be about 4,200 pounds; spacecraft weight in orbit (after jettisoning of escape tower) -- 3,000 pounds; on-the-water recovery weight -- 2,400 pounds. Prime contractor for the spacecraft is McDonnell Aircraft Corp. of St. Louis, Mo.

LAUNCH VEHICLE -- A modified Atlas D is used to launch orbital Mercury missions, reaching a speed of 17,500 miles per hour. At launch, booster and spacecraft stand 93 feet tall, including a 16-foot tower above the spacecraft. The tower contains a solid propellant rocket hooked to an abort sensing system. Should trouble develop on the launch pad or in the early boost phase of the mission, the escape system will be triggered -- automatically or by the pilot or from the ground -- to pull the spacecraft away from the booster. The booster is manufactured by the Astronautics Division of General Dynamics Corp.

NETWORK -- The Mercury Tracking Network consists of 18 stations around the world, including two ships, one on the equator in the Atlantic off the coast of Africa and the other in the Indian Ocean. Some 500 technicians man these stations, all of which are in radio or cable communication with the Mercury Control Center at the Cape via the NASA Goddard Spaceflight Center at Greenbelt, Md.

RECOVERY -- More than 20 ships will be deployed in the Atlantic alone to take care of prime and contingency recovery areas. Recovery forces are under the command of Rear Admiral John L. Chew, Commander of Destroyer Flotilla Four. In addition, ships and rescue planes around the world will go into action in the event of an emergency landing. More than 15,000 men will have a hand in the recovery, search and rescue effort.

RESPONSIBILITIES -- Project Mercury, the nation's first manned space flight research project, was conceived and is directed by the National Aeronautics and Space Administration, a civilian agency of the government charged with the exploration of space for peaceful and scientific purposes. Technical project direction for Mercury is supplied by NASA's Manned Spacecraft Center, directed by Robert R. Gilruth at Langley Field, Va., and soon to move to Houston, Texas. The Department of Defense, largely through the Air Force and Navy, provides vital support for Mercury. DOD support is directed by Major General Leighton I. Davis, USAF, Commander of the Atlantic Missile Range. In all, more than 30,000 persons will have a part in this mission, including government and industry.

PROJECT COST -- Total Project Mercury cost through orbital flight is estimated at \$400 million. About \$160 million will have gone to the prime spacecraft contractor, McDonnell and its subcontractors and suppliers; \$95 million for the network operations; \$85 million for boosters, including Atlases, Redstones and Little Joes; \$25 million for recovery operations and roughly \$35 million for supporting research in diverse areas.

MISSION PILOT TASKS -- The MA-6 pilot will perform many control tasks during flight to obtain maximum data on spacecraft performance, his own reactions to weightlessness and stress, and to study the characteristics of the earth and stars from his vantage point over 100 miles above the earth's surface.

The Astronaut will participate actively during the flight. This will include the following tasks:

- (1) Manage the operation of all spacecraft systems, particularly the attitude control system, electrical system, environmental control system, and communications systems.
- (2) Observe and correct any discrepancies in system operation. Discrepancies will be correlated with telemetered observations received at ground stations.
- (3) Monitor critical events during launch, and terminate the mission if necessary.
- (4) Maintain a complete navigation log during flight which will enable him to compute his retro-fire time if ground communications should fail. This onboard navigation will include periscope ground sightings which indicate position over ground and altitude.

(5) Ground communications to receive updated retro-fire information, and receive detailed detailed behavior of spacecraft systems as determined from ground telemetry.

(6) Evaluate his physical condition to augment the biomedical data which are telemetered to the ground.

About every 30 minutes, the pilot will make detailed voice reports on spacecraft systems and operations conditions. His own transmissions will include critical information as mode of control, precise attitude, planned retro-fire time, control system fuel, oxygen, and coolant.

MISSION PROFILE

POWERED FLIGHT -- The manned Mercury spacecraft will be launched atop an Atlas from Cape Canaveral following a two-day split countdown. Technical conditions or weather could, of course, delay the launch from minutes to days.

According to the flight plan, the spacecraft will be launched on a path along the Project Mercury World-wide Tracking Range on a launch heading of about 72 degrees -- just north of east from Cape Canaveral.

An internal programmer in the Atlas will guide the vehicle from liftoff until staging occurs. All of the Atlas liquid-propellant engines are ignited before lift-off.

At staging, about two minutes after lift-off, the two booster engines will drop off and the sustainer and vernier engines will continue to accelerate the vehicle. Staging occurs at an altitude of about 40 miles and a range of about 45 miles from the launch pad.

During the first 2½ minutes of flight, an electronic brain, called the Abort Sensing and Implementation System (ASIS) is capable of sensing impending trouble in the rocket and triggering the escape rocket. The astronaut can also trigger the Mercury escape rocket to pull the spacecraft away from the Atlas.

About 20 seconds after staging, and assuming the flight is proceeding as planned, the 16-foot escape tower and rocket will be jettisoned. Landing systems will be armed. The Mercury-Atlas vehicle will continue to accelerate toward the orbit insertion point guided by ground command guidance.

Until orbital insertion, the abort sensing system will continue to watch for trouble. If significant deviation should occur, the system will actuate circuits to release the spacecraft-to-Atlas clamp ring and fire the posigrade rockets on the base of the spacecraft.

About five minutes after lift-off, guidance ground command will shut down the sustainer and vernier engines. As the engines shut down, the spacecraft-to-booster clamp ring is released automatically and posigrade rockets are fired to separate the craft from the Atlas.

ORBITAL INSERTION -- After a few seconds of automatic damping - getting rid of any unusual motions - the spacecraft will swing 180 degrees so that the blunt face of the craft is turned forward and upward 34 degrees above the horizontal. From that point on during orbital flight, the spacecraft can be controlled in proper attitude automatically or manually by the pilot.

If all goes well, the Mercury spacecraft will be inserted into orbit in the vicinity of Bermuda. By that time the vehicle will be at an altitude of approximately 100 miles and traveling at a speed of about 17,500 miles per hour. At engine cut-off, the craft will have been subjected to more than $7\frac{1}{2}$ "G". Reentry "G" will also reach $7\frac{1}{2}$.

A three-orbit flight will last approximately $4\frac{3}{4}$ hours; a two-orbit flight, $3\frac{1}{4}$ hours; one orbit, $1\frac{3}{4}$ hours. The Mercury craft will reach a peak altitude (apogee) of about 150 statute miles off the West Coast of Australia and a low point (perigee) of 100 miles, at the insertion point near Bermuda.

REENTRY -- After the desired number of orbits, as the spacecraft approaches the West Coast of North America, retro or braking rockets will be fired to initiate reentry.

Shortly after the retrorockets are fired, the exhausted rocket package will be jettisoned and the spacecraft automatically will assume reentry attitude. "Friendship 7" will begin to encounter more dense atmosphere of the Earth approximately over the east coast at an altitude of about 55 miles. At this point, temperatures will start mounting on the spacecraft's ablation heat shield.

On a nominal mission, peak reentry temperature of about 3,000 degrees F. will occur at 25 miles altitude while the spacecraft is moving at nearly 15,000 miles per hour. All told, the craft will sustain temperatures in this neighborhood for about two minutes.

Almost coincident with the heat pulse is a dramatic reduction in capsule speed. Between 55 miles and 12 miles altitude - covering a distance of 760 miles - spacecraft velocity should go from 17,500 miles per hour down to 270 miles per hour in a little over five minutes.

At about 21,000 feet, a six-foot diameter drogue parachute will be opened to stabilize the craft. At about 10,000 feet, a 63-foot main landing parachute will unfurl from the neck of the craft.

On touchdown, the main chute will be jettisoned. On-board electrical equipment will be shut down, and location aides will be activated.

RECOVERY -- Several new recovery techniques will be tried operationally for the first time in MA-6. If all's well, the astronaut, on leaving the craft via the neck or the side hatch, should be greeted by two frogmen who by that time will have cinched a new flotation belt around the base of the craft. This is to add to the craft's seaworthiness.

Plans call for the frogmen to leap into the water with the quick-inflating belt from one of several recovery helicopters staged off aircraft carriers in the three prime recovery zones. As soon as they have secured the three-foot-high belt, the astronaut will emerge, grab a "horse collar" lift from a hovering helicopter and be whisked up into the copter and to a nearby carrier.

Meanwhile, a smaller ship is to go along side the spacecraft and hoist it onto its deck for transfer to the carrier or direct delivery to the Cape.

THE MA-6 MERCURY SPACECRAFT

The MA-6 spacecraft is similar to those used in previous Mercury flights. About as big as a phone booth, the interior looks much like the cockpit of a high-performance airplane - only smaller.

Here are some of the major items confronting the pilot:

Instrument Panel - Instruments are located on a main instrument panel, a left console, and a right console. The main panel is directly in front of the pilot. Navigational and control instruments are located in the left and center sections of the panel and the periscope is located in the center. The right section of the main panel is composed of environmental system gauges and controls, electrical switches, indicators and communication system controls.

Rate Stabilization and Control - Attitude of the Mercury spacecraft is changed by the release of short bursts of superheated steam (hydrogen peroxide) from 18 thrust nozzles located on the conical and cylindrical portions of the craft's surface. Timing and force of these bursts are controlled by one of the following: (1) Automatic Stabilization and Control System (ASCS), or "Auto-Pilot"; (2) Rate Stabilization and Control System (RSCS), or "Rate Command" System (3) the Manual Proportional Control System, a manual-mechanical system, and (4) the Fly-By-Wire (FBW), a manual-electrical system.

The left console includes sequencing telelights and a warning panel, indicators and controls for the spacecraft's automatic pilot (ASCS), environmental control and landing systems. Altogether, there are over 100 lights, fuses, switches and miscellaneous controls and displays.

Cameras - A 16mm camera is installed to the left of the astronaut's head to photograph the instrument panel display from launch through recovery. A pilot observer camera is mounted in the main instrument panel and will also be operated from launch through recovery.

Periscope - An earth periscope is located approximately two feet in front of the pilot and will provide a 360-degree view of the horizon. The pilot may manually adjust for "low" or "high" magnification. On "low" he will have a view of the Earth of about 1,900 miles in diameter - in "high" the field of view will be reduced to about 80 miles. Altitude can be measured within plus or minus 10 nautical miles. The Mercury-Earth periscope will, in addition, serve as a navigational aid.

Pilot Support Couch - The astronaut's couch is constructed of a crushable honeycomb material bonded to a fiberglass shell and lined with rubber padding. Each astronaut has a flight couch contoured to his specific shape. The couch is designed to support the pilot's body loads during all phases of the flight and to protect him from acceleration forces of launch and reentry.

Restraint System - The restraint system, which consists of shoulder and a chest strap, leg straps, crotch strap, lap belt and toe guards, is designed to keep the astronaut in the couch during maximum deceleration.

Environmental Control System - The environmental control system provides the MA-6 spacecraft cabin and the astronaut with a 100-percent oxygen environment to furnish breathing, ventilation, and pressurization gas required during flight. The system is completely automatic, but in the event the automatic control fails, emergency controls can be used.

The system consists of two individual control circuits (the cabin circuit and the suit circuit), which will normally operate for about 28 hours. Both systems are operated simultaneously. The suit circuit is isolated from the cabin circuit by the astronaut closing the face-plate on his helmet. Unless there is a failure in the cabin circuit causing loss of pressure, the pilot's pressure suit will not be inflated.

Aeromedical Information - Throughout the flight, the physical well-being of the pilot will be monitored. The pilot's respiration rate and depth, electrocardiogram and body temperature will be telemetered to flight surgeons on the ground.

Pilot Communications - The MA-6 astronaut may remain in touch with the ground through the use of high-frequency and ultra-high-frequency radios, radar recovery beacons, and if the situation dictates, a command receiver or a telegraph code key.

Main battery system - Three 3,000 watt-hour batteries and one 1,500 watt-hour battery are connected in parallel to provide power for the complete mission and about a 12 hour post-landing period. A standby backup power system of 1,500 watt-hour capacity is also provided. To further insure reliable operation of the pyrotechnic system, each device has a completely isolated power feed system.

Retro-fire Timer - There will be a timer in the MA-6 spacecraft with three major separate operational components, (1) a standard aircraft elapsed time clock, (2) a "seconds

from launch" digital indicator with a manual reset, and (3) a resettable timer and time-delay relay which will initiate the retrograde fire sequence. When the preset time has passed, the relay closes and actuates the retrograde fire signal, at the same time sending a telemetered signal to the ground.

Altimeter - The Mercury barometer altimeter is a single-revolution indicator with a range from sea level to 100,000 feet. The dial face has reference marks at the drogue and main parachute deployment altitudes.

At the top right corner of the main panel are located environmental displays, providing the pilot with indications of cabin pressure, temperature, humidity, and oxygen quantity remaining.

Food, Water, and Waste Storage - "Friendship 7" will carry about 3,000 calories of food - beef and mixed vegetables - and about six pounds of water. The water will be in two flat bottles, each fitted with a tube. The food is in two tubes, about the size of tooth paste tubes. In addition, there will be some quick-energy sugar tablets.

Survival Equipment - The survival package will consist of a one-man life raft, desalting kit, shark repellant, dye markers, first aid kit, distress signals, a signal mirror, portable radio, survival rations, matches, a whistle, and ten feet of nylon cord.

A new lightweight, radar-reflective life raft is fabricated of Mylar (for air retention) and nylon (for strength). The three-pound, four-ounce raft features three water ballast buckets for flotation stability and a deflatable boarding end which may be reinflated by an oral inflation tube following boarding. The raft, made of the same material used in the Echo satellite balloon, is international orange.

Pilot's Map - A small cardboard diagram of the MA-6 flight path with recovery forces indicated is contained within a bag suspended beneath the periscope. On the reverse side, the pilot's view through the periscope from maximum altitude is shown. Last minute information on cloud formations and weather phenomena will be marked by Mercury weather experts.

Hatch - The MA-6 spacecraft is equipped with a hatch secured by explosive bolts, just as the pilot's canopy is secured in a high performance aircraft. The astronaut can jettison the hatch by pushing a plunger button inside the spacecraft or by pulling a cable. The hatch may also be removed by recovery teams.

Cylindrical Neck Contents - Above the astronaut's cabin, the cylindrical neck section contains the main and reserve parachute system.

Three parachutes are installed in the spacecraft. The drogue chute has a six-foot-diameter, conical, ribbon-type canopy with approximately six-foot long ribbon suspension lines, and a 30-foot-long riser made of dacron to minimize elasticity effects during deployment of the drogue at an altitude of 21,000 feet. The drogue riser is permanently attached to the capsule antenna by a three point suspension system terminating at the antenna in three steel cables, which are insulated in areas exposed to heat.

The drogue parachute is packed in a protective bag and stowed in the drogue mortar tube on top of a light-weight sabot. The sabot functions as a piston to eject the parachute pack, when pressured from below by gasses generated by a pyrotechnic charge.

The function of the drogue chute is to provide a backup stabilization device for the spacecraft in the event of failure of the Reaction Control and Stabilization System. Additionally, the drogue chute will serve to slow the capsule to approximately 250 feet per second at the 10,000 foot altitude of main parachute deployment.

The reserve chute is identical to the main chute. It is deployed by a flat circular-type pilot chute.

Other components of the landing system include drogue motor and cartridge, radar chaff, barostats, antenna fairing ejector, sea marker packet, and two underwater charges - one attached to and deployed by the antenna lanyard and the other fixed to the spacecraft.

Following escape tower separation in flight, the 21,000 and 10,000 foot barostats are armed. No further action occurs until the capsule descent causes the 21,000 foot barostat to close and activate power to the drogue mortar which ejects the drogue as well as the radar chaff - loosely packed under the drogue chute - to provide a target for radar location.

Two seconds after the 10,000 foot barostat closes, power is supplied to the antenna fairing ejector - located above the cylindrical neck section - to deploy the main landing parachute and an underwater charge, which is dropped to provide an audible sound landing point indication. The ultra-high frequency SARAH radio then begins transmitting. A can of sea-marker dye is deployed with the reserve chute and remains attached to the spacecraft by a lanyard.

On landing, an impact switch jettisons the landing parachute and initiates the remaining location and recovery aids. This includes release of sea-marker dye with the reserve parachute if it has not previously been deployed, triggering a high-intensity flashing light, extension of a 16-foot whip antenna and the initiation of the operation of a high-frequency radio beacon.

If after landing, the spacecraft should spring a leak or if the life support system should become fouled after landing, the astronaut can escape through this upper neck section or through the side hatch.

Impact Skirt - Following deployment of the main landing parachute, the heat shield is released, extending the landing-impact bag to form a pneumatic cushion primarily for impact on land, it is also required for capsule stability after water landings.

The air cushion is formed by a four-foot skirt made of rubberized fiberglass that connects the heat shield and the rest of the capsule. After the main parachute is deployed, the heat shield is released from the capsule and the bag fills with air. Upon impact, air trapped between the heat shield and the capsule is vented through holes in the skirt as well as portions of the capsule which are not completely air tight, thereby providing the desired cushioning effect.

THE ATLAS LAUNCH VEHICLE

The launch vehicle to be used for the Mercury-Atlas 6 test is an Atlas D model, one of several Atlases especially modified for use in the Mercury flight test program. This vehicle develops 360,000 pounds of thrust and burns Rp-1, a kerosene-like fuel, and liquid oxygen.

Principle differences in the Mercury-Atlas and the military version of the vehicle include: (1) modification of the payload adapter section to accommodate the Project Mercury spacecraft, (2) structural strengthening of the upper neck of the Atlas to provide for the increase in aerodynamic stress imposed on the Atlas when used for Mercury missions, and (3) inclusion of an automatic Abort Sensing and Implementation System (ASIS) designed to sense deviations in the performance of the Atlas and trigger the Mercury Escape System before an impending catastrophic failure.

The Atlas measures 65 feet from its base to the Mercury adapter section and is 10 feet in diameter at the tank section. With adapter section, spacecraft and escape tower, the Mercury-Atlas stands 93 feet tall.

The Atlas is constructed of thin-gage metal and maintains structural rigidity through pressurization of its fuel tanks. For this flight, the Atlas will have a heavier gage skin at the forward end of the liquid oxygen tank, the same as that used in other launches of Atlas space systems.

All five engines are ignited at the time of launch - the sustainer (60,000 pounds thrust), the two booster engines (150,000 pounds thrust each) which are outboard of the sustainer at the base of the vehicle and two small vernier engines which are used for minor course corrections during powered flight. During the first minute of flight, it consumes more fuel than a commercial jet airliner during a transcontinental run.

ASTRONAUT PARTICIPATION

All seven of Project Mercury's team of astronauts will participate in the MA-6 orbital mission, some as flight controllers from far-flung vantage points around the globe.

Astronauts John H. Glenn, Jr., prime pilot, M. Scott Carpenter, back-up pilot, and Alan B. Shepard, Jr., technical advisor, will be at Cape Canaveral. Astronaut Walter M. Schirra, Jr. will be stationed at the Mercury site at Pt. Arguello, California, and Astronaut L. Gordon Cooper, Jr. will participate from the Mercury tracking station in Muehea, Australia. Astronaut Virgil I. "Gus" Grissom will monitor launch, insertion, landing, and recovery from Mercury's Bermuda station, while Donald K. Slayton will perform spacecraft checkout prior to insertion of the mission pilot.

THE NETWORK

World-wide Mercury Tracking Stations, including ships in the Indian and Atlantic Oceans, will monitor the MA-6 flight. The Space Computing Center of the NASA Goddard Space Flight Center in Greenbelt, Maryland, will make trajectory computations.

During the flight, information will pour into the Space Computing Center from tracking and ground instrumentation points around the globe at the rate, in some cases, of more than 1,000 bits per second. Upon almost instantaneous analysis, the information will be relayed to the Cape for action.

In addition to proving man's capability for surviving in and performing efficiently in space - and since only two other flights have been made along the world-wide tracking network - the test will further evaluate the capability of the network to perform tracking, data-gathering, and flight control functions.

The Mercury network, because of the man factor, demands more than any other tracking system. Mercury missions require instantaneous communication.

Tracking and telemetered data must be collected, processed, and acted upon in as near "real" time as possible. The position of the vehicle must be known continuously from the moment of lift-off.

After injection of the Mercury spacecraft into orbit, orbital elements must be computed and prediction of "look" information passed to the next tracking site so the station can acquire the capsule.

Data on the numerous capsule systems must be sent back to Earth and presented in near actual time to observers at various stations. And during the recovery phase, Spacecraft impact location predictions will have to be continuously revised and relayed to recovery forces.

An industrial team headed by Western Electric Company recently turned over this \$60 million global network to the National Aeronautics and Space Administration.

Other team members are Bell Telephone Laboratories, Inc.; the Bendix Corporation; Burns and Roe, Inc.; and International Business Machines Corporation. At the same time, the Lincoln Laboratory of Massachusetts Institute of Technology also has advised and assisted NASA on special technical problems relating to the network.

Concluding contract involved extensive negotiations with Federal agencies, private industry, and representatives of several foreign countries in the establishment of tracking and ground instrumentation.

The network consists of 18 stations. The system spans three continents and three oceans, interconnected by a global communications network. It utilizes land lines, undersea cables and radio circuits, and special communications equipment installed at commercial switching stations in both the Eastern and Western hemispheres.

The project includes buildings, computer programming, communications and electronic equipment, and related support facilities required to direct, monitor, and provide contact with the nation's orbiting Project Mercury astronaut.

Altogether, the Mercury system involves approximately 60,000 route miles of communications facilities to assure an integrated network with world-wide capability for handling satellite data. It comprises 140,000 actual circuit miles - 100,000 miles of teletype, 35,000 miles of telephones, and over 5,000 miles of high-speed data circuits.

Sites linked across the Atlantic are: Cape Canaveral, Grand Bahama Island, Grand Turk Island, Bermuda, Grand Canary Island, and a specially fitted ship in Mid-Atlantic.

Other stations in the continental United States are at Pt. Arguello in Southern California; White Sands, New Mexico; Corpus Christi, Texas; and Eglin, Florida. One station is located on Kauai Island in Hawaii.

There are two radar picket ships. The Atlantic Ship Rose Knot will be stationed on the equator near the West African coast. The Indian Ocean Ship Coastal Sentry will be located midway between Zanzibar and Muchea, Australia.

Stations at overseas sites include one on the south side of Grand Canary Island, 120 miles west of the African Coast; Kano, Nigeria, in a farming area about 700 rail miles inland; Zanzibar, an island 12 miles off the African coast in the Indian Ocean; two in Australia - one about 40 miles north in Perth, near Muchea, and the other near Woomera; Canton Island, a small coral atoll about halfway between Hawaii and Australia; one in Mexico, near Guaymas on the shore of the Gulf of Mexico; and one in Bermuda, an independent, secondary control center.

Some 20 private and public communications agencies throughout the world provided leased land lines and overseas radio and cable facilities.

Site facilities include equipment for acquiring the spacecraft; long range radars for automatic tracking; telemetry equipment for receiving data on the spacecraft and the astronaut; command control equipment for controlling the manned vehicle from the ground, if necessary, and voice channels for ground-to-air communications. The extensive ground communications system interconnects all stations through Goddard and the Mercury Control at Cape Canaveral.

Sites equipped with tracking radars have digital data conversion and processing equipment for preparing and transmitting information to the computing system without manual processing, marking a significant achievement - global handling of data on a real-time basis.

One function of the computer is to transmit information regarding the spacecraft's position to Mercury Control Center at the Cape, where it is displayed on the world map in the Operations Room. The computer also originates acquisition information which is automatically sent to the range stations.

During every major Mercury launch, the attention of some 15 NASA flight controllers is focused on dozens of consoles and wall displays in the Mercury Control Center Operations Room. This room is the control point for all information that will flow through the world-wide tracking and communications system. In this room NASA Flight Controllers make all vital decisions required, and issue or delegate all commands.

In the fifty-foot square room, about 100 types of information register at various times on the indicators of the consoles and the high range-status map. Of these 100 quantities, 10 show biomedical condition, approximately 30 relate to life support facilities and about 60 give readings on spacecraft equipment. This information flows in on high-speed data circuits from computers at the Goddard Center, on direct teletype circuits from remote sites, and by booster and spacecraft telemetry relayed over radio and wire circuits.

Three kinds of data start pouring into the computing system as soon as the booster lifts half an inch off the launch pad:

1. Radar data: Triggers the Cape Canaveral IBM 7090 which monitors the spacecraft's flight path and predicts its impact point if the mission must be aborted.
2. Guidance data: Radioed from the spacecraft to a special purpose computer at the Cape.
3. Telemetry data: Reports check points, e.g., lift-off, booster separation.

These data are transmitted from Cape Canaveral to Goddard where IBM 7090's compare the spacecraft trajectory to a pre-determined flight path - and flash the results back to Canaveral. This is a "real time" operation - that is, the system receives, moves it over 2,000 miles, analyzes, predicts and displays data so fast that observers and controllers follow events as they happen.

COMMUNICATIONS INFORMATION

The system carries telephone, teletype and high-speed data (1,000 bits per second) information. It can accept a message from a distant site and deliver it to the final destination - regardless of location - in a little over one second.

Radio teletype facilities use single sideband transmitters, which are less susceptible to atmospheric interference. All circuits, frequencies and paths were selected only after a careful study of data accumulated over 25 years by the National Bureau of Standards on the various propagation qualities of many radio paths.

Submarine cables to London (via New York), to Hawaii (via San Francisco), and to Australia (via Vancouver, B.C.) are included in the Mercury communications network.

The Mercury Voice Network has a twofold mission:

1. Provide Mercury Control Center (MCC) with "real time" information from world-wide tracking stations having the orbiting Mercury spacecraft in view.
2. Provide a rapid means for dealing with emergency situations between MCC and range stations during a mission.

The network is essentially a private line telephone system radiating from GSFC to MCC and the project's world sites.

These lines are used during an orbit mission to exchange verbal information more rapidly than can be done by teletype. Conversations are recorded both at Goddard and Mercury Control Center for subsequent playback. When not used for orbit exercises, the circuits are utilized for normal communications operations.

ASTRONAUT TRAINING PROGRAM SUMMARY

Here are some of the general training activities that the Project Mercury astronauts have undergone since May, 1959.

1. Systems and vehicle familiarization - The seven astronauts were given lectures in the vehicle systems by NASA and several of the contracting companies. NASA Langley Research Center gave them a 50-hour course in astronautics. McDonnell Aircraft Corp. engineers talked to the astronauts on Mercury subsystems. Lectures were given to the astronauts by Dr. William K. Douglas on aeromedical problems of space flight. At the Navy centrifuge in Johnsville, Pa., the astronauts flew the Mercury acceleration profiles. At several Air Force bases they flew brief zero-gravity flight paths. Checkouts of the Mercury environmental system and the pressure suit were accomplished at the Navy Air Crew Equipment Laboratory in Philadelphia. At the Naval Medical Research Institute they became familiar with the physiological effects of high CO₂ content in the environment. The Army Ballistic Missile Division and its associated contractors indoctrinated them on the Redstone. The Air Force Space Systems Division and its associated contractors told the astronauts about the Atlas launch vehicle.

2. Star recognition - Each astronaut periodically received concentrated personal instruction on the elements of celestial navigation and on star recognition at the Morehead Planetarium, Chapel Hill, North Carolina. A trainer simulating the celestial view through a spacecraft window permitted astronaut practice in correcting yaw drift.

3. Desert Survival - A 5½ day course in desert survival training was carried out at the USAF Training Command Survival School at Stead Air Force Base, Nevada. The course consisted of survival techniques through lectures, demonstrations, and application in a representative desert environment. The Mercury survival kit was also evaluated during this period.

4. Egress training - During March and April, 1960, open-water normal egress training was conducted in the Gulf of Mexico off Pensacola, Florida. Each astronaut made at least two egresses through the upper hatch (up to 10-foot swells were experienced). Water survival training was also accomplished in August, 1960 and December, 1961 at Langley. Each of the astronauts made underwater egresses, some of which were made in the Mercury pressure suit.

5. Specialty assignments - The astronauts contributed to the Mercury development program by working directly with Manned Spacecraft Center engineers and by attending NASA-McDonnell coordination meetings and booster panel meetings in their specialty areas. Astronaut specialty areas are:

- Carpenter** - Communications equipment and procedures, periscope operation, navigational aids and procedures.
- Cooper** - Redstone booster, trajectory aerodynamics, countdown, and flight procedures, emergency egress and rescue.
- Glenn** - Cockpit layout, instrumentation, controls for spacecraft and simulation.
- Grissom** - Reaction control system, hand controller, autopilot and horizon scanners.
- Schirra** - Environmental control systems, pilot support, and restraint, pressure suit, aeromedical monitoring.
- Shepard** - Recovery systems, parachutes, recovery aids, recovery procedures and range network.
- Slayton** - Atlas booster and escape system including Atlas configuration, trajectory, aerodynamics, countdown, and flight procedures.

3. Desert Survival - A 5 1/2 day course in desert survival training was carried out at the USAF Training Command Survival School at Stead Air Force Base, Nevada. The course consisted of survival techniques through lectures, demonstrations, and application in a representative desert environment. The Mercury survival kit was also evaluated during this period.

4. Exposure training - During March and April, 1960, open-water normal exposure training was conducted in the Gulf of Mexico off Pensacola, Florida. Each astronaut made at least two exposures through the upper hatch (up to 10-foot swells were experienced). Water-2-7 survival training was also accomplished in August, 1960 and December, 1961 at Langley. Each of the astronauts made underwater exposures, some of which were made in the Mercury pressure suit.

MERCURY LAUNCH CHRONOLOGY

Two types of Mercury spacecraft have been used in the flight test program. First series of shots used full-scale "boilerplate" models of the capsule to check out booster-spacecraft integration and the escape system. Second phase of the development firing program used Mercury capsules built to production standards.

This is the chronology of test firings:

September 9, 1959: Big Joe. NASA-produced research and development capsule, launched on an Atlas from Cape Canaveral -- test validation of the Mercury concept. Capsule, survived high heat and airload and was successfully recovered.

October 4, 1959: Little Joe 1. Fired at NASA's Wallops Station, Virginia, to check matching of booster and spacecraft. Eight solid-propellant rockets producing 250,000 lbs. of thrust drove the vehicle.

November 4, 1959: Little Joe 2. Also fired from Wallops Station, was an evaluation of the low-altitude abort conditions.

December 4, 1959: Little Joe 3. Fired at Wallops Station to check high-altitude performance of the escape system. Rhesus monkey Sam was used as test subject.

January 21, 1960: Little Joe 4. Fired at Wallops Station to evaluate the escape system under high airloads, using Rhesus monkey Miss Sam as a test subject.

May 9, 1960: Beach Abort Test. McDonnell's first production capsule and its escape rocket system were fired in an off-the-pad abort escape rocket system. (Capsule 1).

July 29, 1960: Mercury-Atlas 1. This was the first Atlas-boosted flight, and was aimed at qualifying the capsule under maximum airloads and afterbody heating rate during reentry conditions. The capsule contained no escape systems and no test subject. Shot was unsuccessful because of booster system malfunction. (Capsule 4).

November 8, 1960: Little Joe 5. This was another in the Little Joe series from Wallops Station. Purpose of the shot was to check the production capsule in an abort simulating the most severe Little Joe booster and the shot was unsuccessful. (Capsule 3)

November 21, 1960: Mercury-Redstone 1. This was the first unmanned Redstone-boosted flight, but premature engine cutoff activated the emergency escape system when the booster was only about one inch off the pad. The booster settled back on the pad and was damaged slightly. The capsule was recovered for re-use. (Capsule 2)

December 19, 1960: Mercury-Redstone 1A. This shot was a repeat of the November 21 attempt and was completely successful. Capsule reached a peak altitude of 135 statute miles, covered a horizontal distance of 236 statute miles and was recovered successfully. (Capsule 2)

January 31, 1961: Mercury-Redstone 2. This was the Mercury-Redstone shot which carried Ham, the 37-lb. chimpanzee. The capsule reached 155 statute miles altitude, landed 420 statute miles downrange, and was recovered. During the landing phase, the parachuting capsule was drifting as it struck the water. Impact of the angle blow slammed the suspended heat shield against a bundle of potted wires, which drove a bolt through the pressure bulkhead, causing the capsule to leak. Ham was rescued before the capsule had taken on too much water. (Capsule 5)

February 21, 1961: Mercury-Atlas 2. This Atlas-boosted capsule shot was to check maximum heating and its effect during the worst re-entry design conditions. Peak altitude was 108 statute miles; re-entry angle was higher than planned and the heating was correspondingly worse than anticipated. It landed 1425 statute miles downrange. Maximum speed was about 13,000 mph. Shot was successful. (Capsule 6)

March 18, 1961: Little Joe 5A. This was a repeat of the unsuccessful Little Joe 5; it was fired at Wallops Station and was only marginally successful (Capsule 14)

April 25, 1961: Mercury-Atlas 3. This was an Atlas-boosted shot attempting to orbit the capsule with a "mechanical astronaut" aboard. But 40 sec. after launching the booster was destroyed by radio command given by the range safety officer. The capsule was recovered and will be fired again. (Capsule 8)

April 28, 1961: Little Joe 5B. This was the third attempt to check the escape system under worst conditions, using a Little Joe booster fired from Wallops Station. Capsule reached 40,000 ft., and this time the shot was a complete success. (Capsule 14)

May 5, 1961: Mercury-Redstone 3. This Redstone-boosted shot carried Astronaut Alan B. Shepard, Jr. on a ballistic flight path reaching a peak altitude of 116 statute mi. and a downrange distance of 302 statute mi. Flight was successful. (Capsule 7)

July 21, 1961: Mercury-Redstone 4. This successful flight carried Astronaut Virgil I. "Gus" Grissom to an altitude of 118 statute miles and 303 miles downrange. The capsule sank despite helicopter recovery efforts. (Capsule 11)

September 13, 1961: Mercury-Atlas 4. This successful flight saw the spacecraft attain orbit for the first time. The craft carried a "crewman simulator" designed to use oxygen and put moisture into the cabin at about the same rate as a man. Craft was recovered as planned about 160 miles east of Bermuda after one orbit. (Capsule 8)

November 29, 1961: Mercury-Atlas 5. The flight successfully carried the chimpanzee Enos through two orbits to a smooth landing. The craft was recovered about 260 miles south of Bermuda. (Capsule 9)



NEWS RELEASE

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Fact Sheet

MERCURY-ATLAS 6 ASTRONAUT TO PERFORM MANY PILOT TASKS

The Mercury-Atlas 6 pilot will perform many critical tasks for operation and evaluation of his spacecraft during the first manned orbital flight conducted by the United States. The astronaut will obtain maximum data on spacecraft performance, his own reactions to weightlessness and stress, and characteristics of the earth and stars as viewed from his position over 100 miles above the earth.

To Manned orbital flight, ultimate objective of the Manned Spacecraft Center's Project Mercury, has evolved through progressive research and development to demonstrate the capability of orbiting and safely recovering a man from the environment of space. Each preceding flight -- Little Joe, Mercury-Redstone and Mercury-Atlas -- has been another logical step in the Mercury program.

During the Mercury-Redstone 3 mission, Alan B. Shepard, Jr. worked hard and fast. Within the 5-minute period of weightlessness, he carried out many more tasks than are usually attempted in a similar period of aircraft flight testing. For instance, he used the manual control system one axis at a time: first pitch, then yaw, then roll.

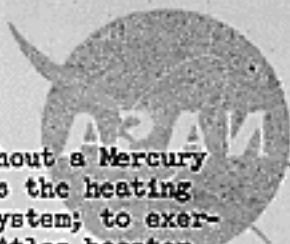
With Shepard encountering no difficulties in his maneuvers, Virgil I. "Gus" Grissom in his Mercury-Redstone 4 flight simply flipped a switch and pulled a special "T" handle on his left console, placing all three axes of the spacecraft at his command; for he then had more time for observation.

Both Mercury-Redstone pilots manually fired their retrorockets and tested their UHF and HF communications systems.

First-order objectives of the Mercury-Atlas 5 flight, in which the chimpanzee, Enos, made two orbits around the earth, were to demonstrate performance of the Environmental Control System by using a primate during a three-orbit mission; to demonstrate

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satisfactory performance of spacecraft systems throughout a Mercury orbital mission; to determine by detailed measurements the heating rates and thermal effects throughout the spacecraft system; to exercise the satellite clock to determine ability of the Atlas booster to release the Mercury spacecraft in prescribed orbital insertion condition; to demonstrate satisfactory performance of the Mercury Worldwide Tracking Network in supporting an orbital mission; to demonstrate ability of Flight Controllers to satisfactorily monitor and control an orbital mission; and to demonstrate adequacy of the recovery plan for an orbital mission with particular emphasis on safety of the pilot.

The decision to end the MA-5 flight after the second orbit demonstrated the effectiveness of the Mercury range stations in locating spacecraft trouble and initiating unscheduled spacecraft return.

MA-5 second-order objectives were to evaluate performance of the Abort Sensing and Implementation System; to determine the magnitude of the sustainer/vernier residual thrust or impulse after cutoff; to obtain data on repeatability of performance of all Atlas missile and ground systems; and to observe Enos in order to learn the possible effects of orbital flight on Mercury astronauts during a prolonged period of floating in space without the familiar sensation of normal weight.

The Mercury-Atlas 6 astronaut will perform eight basic functions during his orbital flight.

The primary flight task can be called "systems management," for it includes monitoring the environmental control system, electrical system, attitude control system and communications system, and in the event of malfunction, determining the nature of the problem, its effect on the mission, and taking over manual control where necessary.

A secondary task, "programming" or "sequence monitoring," is a type of systems management with several unique factors, giving it special interest. This activity involved monitoring of critical events during launch and reentry. These events -- separation from the booster, retrofire, deployment of parachutes, and such -- are critical to a successful mission and involve rapid and accurate reactions to malfunction cues.

Control of vehicle attitude is an important pilot task and involves a number of unique problems not encountered in standard aircraft.

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Another task is navigation. The MA-6 astronaut must know his position at all times. This knowledge involves both ground references and astronavigation.

Communications, an important subtask, plays a more significant part of the space mission than in standard aircraft operations. Through communications, the astronaut will receive important navigation, fuel management, and trajectory data while keeping ground stations informed of flight progress.

Research observations are a must as a flight task for this mission, for a basic goal of the entire Mercury program is to evaluate man's capability in space. The MA-6 astronaut has an important role in this research and in evaluation of data available to him from his unique position in space.

To accomplish the above in-flight tasks, the astronaut will have to be able to keep himself in good condition under physical stresses which he will meet. He must apply special skills developed for meeting acceleration, weightlessness, heat and other phenomena.

Finally, the flight will begin with a period of ground launch preparation and countdown and will end with a period of waiting for pickup on the surface of the ocean, during which he will have many important responsibilities.

The following gives these eight basic functions in greater detail.

SYSTEMS MANAGEMENT -- For a successful MA-6 mission, four major spacecraft systems -- attitude control, environmental control, electrical system and communications system -- must function correctly throughout the flight. If one system fails, the pilot must activate its backup system. In addition, he must determine the effect of the failure and take proper action to modify the mission if it is no longer possible to accomplish the original objectives.

Systems management may become one of the most important areas of man's activities in space flight. In later, prolonged periods of flight without access to ground support, there will be special emphasis on maintaining functions of all systems. This requirement exists only partially in the Mercury spacecraft. Total Mercury flight profile of 4-1/2 hours is well within the flight time of conventional aircraft; however, even in the most dire emergency the astronaut cannot bail out while in orbit. Thus, Mercury represents an intermediate step between aircraft and long-life space vehicles in basic system reliability requirements.

First step in the astronaut's systems management task is to monitor spacecraft instrumentation carefully enough to perceive failures when they occur. The most dangerous Mercury malfunction in terms of mission consequences -- or in terms of difficulty for the pilot to notice -- are set on warning systems which provide both a tone and a light cue on the annunciator panel. The purpose of this annunciator panel is to reduce requirements for continuous vigilance. Following perception of failure, the pilot may take immediate emergency action to insure safety from further damage or deterioration due to system malfunction.

Thus, emergency procedures are designed to block further vehicle damage or to protect the astronaut, guaranteeing that man and vehicle are safe, and allowing time for the next step in pilot reaction to system malfunction. This pilot reaction step is isolation of the failure, not necessarily determining the exact component which has failed but what functions have been lost and under what conditions or to what extent he can return to the primary system.

Corrective actions in the spacecraft are, of course, extremely limited, and have led to the question of whether failure isolation is a significant requirement.

There is, however, another strong requirement for failure isolation. Even if it is impossible to correct a failure and thus return to the primary system, it may not compromise the mission. In some cases, sufficient redundancy is provided, so that secondary systems can carry out the full mission program.

In other cases, failure with relatively little effect at the moment may have great significance for the duration of the mission. For this reason, it is important to isolate a failure as carefully as possible so that the mission may be reevaluated.

In this reevaluation, certain other factors come into scope: remaining quantities of various consumables; present position of the craft and predicted time to normal landing area; and over-all operational objectives. If -- based on this analysis -- a change in flight program is required, the pilot takes necessary steps to initiate early retrofire and reentry. During these steps, of course, he coordinates his activities with Mercury range stations, receiving the benefit of analysis and advice of systems specialists on the ground.

SEQUENCE MONITORING -- During the MA-6 flight, the series of events to take place will be carefully programed to occur in correct sequence and at the proper time. During launch, the

escape tower must be jettisoned when no longer needed. The spacecraft must separate from the booster. On reentry, retrofire maneuver must be carried out, retrorockets jettisoned, autopilot properly programmed, parachutes and impact bag deployed. These events are controlled by automatic sequencing systems, but to permit the astronaut to backup this programming system a set of display lights for each major launch event and reentry sequence has been placed on the left-hand section of the instrument panel. Associated with each light is the astronaut's manual override.

ATTITUDE CONTROL -- Launch is automatically programmed through the Atlas booster, so the pilot has no attitude control problem while still attached to the missile. When in orbit and during reentry, the spacecraft attitude may be controlled either by the pilot or autopilot. In controlling attitude, the astronaut may encounter four basic types of problems: controlling attitude in orbit; controlling attitude during retrofire; rate damping during reentry; and recovery from tumbling maneuvers.

The second and most difficult type of problem faced in Mercury attitude control is maintenance of attitude during retrofire; here the pilot must hold spacecraft position within certain tolerances for full retrofire value. Retrorockets will be aligned so that their force will pass through the center of gravity of the vehicle. However, if retrorockets are not perfectly aligned at retrofire, they will produce torques about the major axes of the vehicle, particularly in yaw and pitch. These torques develop rapid rates of motion about the axes which must be controlled by the pilot.

A third attitude control problem is reentry rate damping. The spacecraft is statically stable on reentry. However, during reentry, it may experience oscillations about the reentry attitude. Large oscillations may produce excessive heating on the afterbody. The pilot, in event of failure of the automatic system, must damp these oscillations.

A final problem is recovery from a tumbling maneuver. It is possible that on separation from the booster, the craft may receive a torque which will cause it to tumble. This may cause gyro gimbal lock and result in incorrect attitude indications. Rate indicators, however, will not be affected by tumbling and will give an accurate indication of the movement about the three axes of the vehicle. In this situation, the astronaut brings his rate to zero and then can manually reorient spacecraft attitude.

To perform the above tasks, the astronaut has three manual attitude-control systems in addition to the basic automatic control system: a "fly-by-wire" system, which works through the autopilot; a direct manual system, which works through mechanical linkages to the manual control fuel system; and a rate-command system which also uses the manual fuel system.

The astronaut has three basic display systems: instruments, including a rate and attitude display; periscope for ground viewing and determination of earth vertical; and a window for viewing earth's horizon.

External attitude reference presents some special problems. Through the observation window, the pilot will get a view of the earth for roll and pitch reference as long as the horizon can be seen. But on the dark side of the earth in the absence of the moon, the horizon will be difficult to see.

The most valuable yaw reference will probably be the stars as seen through the window, since they will remain fixed in yaw relative to the spacecraft's orbit.

Like the window, the periscope will provide relatively good reference for pitch and roll control. But yaw reference through the periscope may be difficult, since much of the mission will be over clouds or water which may not provide a good drift reference. Also, since the periscope reduces the size of the earth to $1/9$ scale, roll and pitch rates will be $1/9$ of those taken by window observation or from instruments.

NAVIGATION -- The astronaut must know his position at all times. The first and most essential navigational requirement is impact point prediction and control. The vehicle will orbit at approximately 5 miles per second. Normal recovery zones at the end of each orbit is about 150 miles. Since the nominal impact point will be in the center of a recovery zone, an error of 75 miles would place the spacecraft outside the primary recovery area. Thus, exact impact point prediction is highly desirable.

The second specific requirement for knowledge of position is communication with ground stations and observation of predetermined check points. Contact with stations will vary between 2 to 5 minutes. For such short passes, the pilot will have to be alert and ready to communicate.

COMMUNICATIONS -- Through the medium of communications, complex Mercury mission systems are coordinated. Critical parts of the launch range and recovery systems are the blockhouse, booster guidance systems,

Spacecraft position at any time can be calculated from the nominal trajectory. The astronaut is provided a map on which elapsed time since launch is marked along the orbit track in minute intervals, permitting him to determine his estimated position by referring to the elapsed time clock. In the nominal trajectory, estimated time of arrival over any given point should be calculable within 15 seconds.

Three methods are available to the astronaut for checking accuracy of a nominal trajectory. Probably the most accurate method, assuming proper function of the complex range system, will be the ground computed position. This system depends upon radar trajectory data from the launch site and from the Mercury tracking sites. On the basis of this information, computers will provide accurate retrotime in terms of elapsed time. These data will be transmitted along the range network and then to the astronaut. If all components of this system function correctly, they should provide a high level of accuracy in computing specific retrotime.

Another method for the astronaut to update nominal trajectory information is by use of ground reference. Through the spacecraft periscope, passage of ground check points can be timed. From these ground fixes, nominal orbital data may be modified. Use of ground reference, of course, depends upon good visibility, proper alignment in attitude and an accurate clock.

The third method of correcting nominal trajectory is through celestial reference. This method depends upon visibility of constellations of the Zodiac, proper attitude orientation, and an accurate clock.

Of the factors affecting the pilot's determination of his position from external fixes, the accuracy of the spacecraft clock should provide least error. The clock is fully qualified for conditions expected during the flight.

Attitude control greatly favors use of ground check points. The autopilot will maintain spacecraft attitude within 3° about the three axes of the vehicle. Effect of such errors is smaller in the case of ground check points than in star reference. An error of 1° in maintaining earth vertical would result in less than a 2-mile error in ground reference at an altitude of 100 miles, where a 1 degree error in celestial navigation would result in a 60-mile error.

COMMUNICATIONS -- Through the medium of communications, complex Mercury mission systems are coordinated. Critical units of the launch range and recovery systems are the blockhouse, booster-guidance systems, the Mercury range, a computer center, and recovery units.

The astronaut will communicate with the blockhouse and Mercury Control Center during launch, with range stations during flight, and with recovery forces in his area following flight. Range sites are situated around the world in such positions that the pilot will be able to communicate with them approximately 50 percent of his time in orbit. The longest period between stations will be about 20 minutes.

Through this range network, the astronaut will receive seven basic types of information. During launch, he will receive information on booster and spacecraft trajectory. This communication is essential since the astronaut has no immediate information on booster status.

The ground station will inform him on the progress of powered flight and inform him immediately of any booster or ground guidance problems. The second type of information from the ground will be sequencing cues. During launch and reentry, the astronaut can be given indication when certain important events such as tower jettisoning, separation, and parachute deployment should occur. These data can be based on ground time or ground trajectory information.

A third ground system function will serve to provide the astronaut with backup in systems monitoring. Generally, he has more complete information on the function of the vehicle system than ground personnel; however, he may fail to note an indication of malfunction. Moreover, in some cases, the ground monitor has information not available to the astronaut. In these cases, the flight controller is able to feed additional data to him for evaluation.

Based on the astronaut's description of events in the craft together with telemetered data, engineers on the ground may be able to advise him on the cause of any abnormal function of spacecraft systems.

Fourth, the astronaut will receive medical information on his own physiological status. On the ground, the flight surgeon has available to him telemetered heart rate, respiration rate, and temperature. These data, of course, are not available to the astronaut, and his subjective feelings may not be reliable -- particularly under flight conditions; therefore, medical monitors are in position to alert him should medical problems develop.

A fifth function of ground personnel will be to maintain graphs of major items such as fuel, cooling water, oxygen and other consumables. These plots are based on telemetered data confirmed by reports from the astronaut and can be evaluated by ground personnel to determine that the rate of use of these items is as programed.

A sixth ground service serves to provide information on weather, recovery ships, and range status. Weather information is critical, not only because sudden changes in weather status might make reentry in one of the planned areas undesirable, but also because weather will control the astronaut observations and his ability to make ground checks for a position. Status of recovery ships may also influence choice of his recovery point, while the status of range stations may determine where he will be able to communicate.

Finally, communications to the pilot will serve the purpose of updating time and navigation information. The pilot will begin navigation, based on nominal trajectory. Based on actual insertion parameters, range personnel will be able to inform him of deviations from the nominal trajectory which will permit him to determine his position more precisely.

In addition to this information sent to the spacecraft, the astronaut transmits four types of data:

(1) He will send reports on his own status, his subjective feelings and his apparent well being.

(2) He will transmit information on spacecraft systems status, including information on the mode of control he is using, whether he is on primary or secondary systems, and similar data. In addition, he will report instrument readings on critical parameters such as fuel and oxygen quantities to verify and cross-check against ground telemetry data.

(3) He will give mission status as he understands it; his position, based on his own navigational fixes; his retrotime; and status of his planned program of activities.

(4) He will pass along information concerning his own observations, his own performance, the vehicle and its performance, and the external environment.

Three critical decisions can be made through use of communications. First, the astronaut -- with ground information and advice -- may determine what corrective actions are to be taken in a given situation. Since the astronaut has the most complete information on vehicle systems, most corrective action will result directly from his own knowledge of the

vehicle and information. However, in some instances, information and advice from the ground may play an important role in taking corrective action, particularly where medical information plays a role in determining the need for action.

A second critical decision through communications will be the "Go -- No Go" decision just prior to insertion of the spacecraft into orbit. If an abort is to be made due to spacecraft status, it must be completed prior to burnout of the sustainer stage. Thus, a positive decision is required just prior to burnout -- that the spacecraft and astronaut are in proper condition to be inserted into orbit. This decision is made by the ground flight controllers and the astronaut.

A final decision area is one to terminate the mission if malfunctions develop or if range conditions do not permit recovery in the planned third orbit area. The decision of where and when to terminate the mission is a critical one, requiring precise information on required time for retrofire and maximum coordination between astronaut and tracking range.

IN-FLIGHT RESEARCH -- Research and evaluation involving the astronaut can be divided into four general categories:

(1) The astronaut will be required to make evaluations of vehicle performance -- traditional job of the test pilot. He reports to ground stations all indications of vehicle performance, particularly in areas where telemetry or onboard record systems are not providing measurement. He also investigates maneuvers not provided for in automatic programming of the system, thereby evaluating the system under unusual conditions which can more fully test its capabilities.

(2) He will observe the space environment, including heavenly bodies and the earth below to gain information valuable to scientists in such areas as astronomy and meteorology.

(3) By receiving physical examinations before and after the mission, by reporting any medical symptoms which he may experience, and by allowing medical personnel to draw blood and urine samples, he will provide medical data for analysis of human physiological responses to the space environment.

(4) By performing his in-flight activities, such as monitoring vehicle systems, making voice reports, controlling vehicle attitudes and in certain cases doing special performance tasks, he provides data for evaluation of his performance capability under weightless conditions.

PHYSICAL STRESS MANAGEMENT -- During flight, the astronaut will be exposed to acceleration, reduced pressure, heat, vibration, noise, and possibly such abnormal conditions as tumbling and high levels of carbon dioxide. If he is to perform all his tasks, he must react appropriately to these stresses. He must sense these conditions to the extent that they provide cues to system functions during the mission. At the same time, he must not allow them to divert his attention from flight tasks.

In some cases, there are specific skills in management of these stresses which can be learned and practiced. For example, to minimize "grey out" and substernal pain due to transverse "g" the astronaut can employ a straining technique, learned in centrifuge training earlier in the program. In addition, through somewhat subtler changes produced through repeated exposure to physical conditions of the flight, an adaptation to these stresses will maximize his resistance to performance hindrances. He must regulate his behavior and activity level so that he does not fatigue himself while in the full pressure suit.

During reentry and postlanding heat rise, he must remain as quiet as possible so as not to generate extra heat and complicate the heating problem. Thus, the astronaut must be aware of his own function and its interreaction with the environmental control system which supports him.

GROUND TASKS ASSOCIATED WITH LAUNCH -- The astronaut has an important role in preparation of the spacecraft for launch and flight. During the prelaunch period, the spacecraft will be mated to the launch vehicle and then will be checked for compatibility between craft and booster systems. Many of these checks will require operation of controls within the vehicle. For both training and proper equipment checkout the astronaut will take part in these activities. Also, during countdown, he will observe and aid in preparation of the vehicle, communicating with the blockhouse and participating in the part of the countdown associated with checkout of the vehicle and astronaut system.

Thus, the MA-6 astronaut will be well occupied up to and throughout his flight. But this is only the culmination of a long series of non-flight tasks which began shortly after the seven astronauts reported to Manned Spacecraft Center's Project Mercury in April 1959. These nonflight tasks included long hours of training and desk work, spacecraft couch and pressure suit fitting. Visits to McDonnell Aircraft Corporation included lectures, views of spacecraft mockups and suggestions and design studies for pilot-space layout, instrumentation, and control systems.

Survival training, endless medical examinations, centrifuge experience, navigation, star recognition, code and map study, ALFA and procedures trainer experience, egress training, weightlessness exposure,

... flying high performance jet aircraft, development of operational procedures and technology -- all this was preparation for the climactic astronaut's mission -- manned orbital space flight. ... possibly such as carbon dioxide. If he is to perform all his tasks, he must react appropriately to these stresses. He must sense these conditions to the extent that they provide cues to system functions during the mission. At the same time, he must not allow them to divert his attention from flight tasks.

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Survival training, endless medical examinations, centrifuge experience, navigation, star recognition, code and map study, AFA and procedures training, experience, stress training, weightlessness exposure,



NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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FOR RELEASE:

IMMEDIATE

FACT SHEET

EMERGENCY EGRESS COMMITTEE FORMULATES ALL LAUNCH PAD RESCUE PLANS FOR MERCURY

Astronaut safety during Launch phases of Manned Space Flight is foremost in Project Mercury planning. Emergency Egress on the Cape Launch Pad, first step in advance preparation for every conceivable emergency through spacecraft recovery, is planned by an Emergency Egress Committee headed by Major L. Gordon Cooper, Mercury Astronaut.

Maj. Cooper's committee was named over two years ago to formulate emergency rescue plans with maximum safety for the astronaut and minimum hazardous conditions for launch personnel and rescue operations.

Launch pad rescue of the astronaut is the prime responsibility of a well-trained Mercury Emergency Egress Team, composed of highly qualified representatives from NASA, McDonnell Aircraft Corporation, U.S. Air Force and Pan American.

Detailed Egress procedures covering every foreseen malfunction possibility are published in handbook form prior to each launch. However, since remote possibilities always exist, successful rescue operations largely depend on response, skills and adaptability of rescue personnel involved.

Weeks prior to scheduled launches, rescue team members spend every possible hour in training for their roles in astronaut safety. Practice by both individuals and teams is performed continuously -- such as handling the Cherry Picker around a dummy spacecraft on an old Mercury-Redstone launch pad.

Approximately one week prior to launch -- right after a simulated countdown -- all launch pad rescue vehicles and crews participate in rescue practice. A dress rehearsal is held at this time for the rescue team to practice with the astronaut until the entire operation is considered ready.

WORD ONE/KEYSEARCH

D 00-00-00 HQS N 00 KMER Emergency Egress Committee HQS R20012
Formulates All Launch Pad
Rescue Plans For Mercury
MA-6

Immediately prior to launch at T minus 120 minutes, the astronaut is inserted into the spacecraft and "sealed" in by T-65. The gantry serves as a method of egress until retracted at T-52. A stationary escape tower 25 feet from the launch stand then serves egress purposes. The tower, a modified umbilical tower for the Midas program, includes an elevator that can be lowered to the ground within 60 seconds, and an automatically or manually operated catwalk that can be lowered in less than 30 seconds to the spacecraft hatch. Prime backup for this tower is a cherry picker, positioned at the blockhouse to be moved forward by a blockhouse-stationed operator.

Basic philosophy of Cooper's Emergency Egress Committee is that the astronaut is safest inside the spacecraft -- with its ability to abort -- under most emergency conditions. However, possibility of spacecraft internal fire or development of some condition endangering the life of the astronaut while inside the craft has been recognized and prepared for.

The astronaut is capable of aborting his mission at using the spacecraft escape tower rockets to carry his craft several hundred feet out of danger within . . . Prior to use of the escape rockets, he can blow the side egress hatch, climb onto the egress tower, ride the elevator to ground level and be picked up by rescue vehicles and removed from the danger area in a matter of minutes.

Beyond a high fence some 300 yards from the launch pad will stand alerted armored personnel carriers (M-113's). An open gate will permit their immediate access to the pad. One vehicle equipped with dry chemical firefighting materials is manned by a Pan American fireman and commanded by Pan American Assistant Fire Chief Lee Hipp.

The second Army vehicle carries a five-member rescue squad. Vehicle commander is a Pan American pad safety man, chosen for his knowledge of explosives and safety requirements at pad areas under critical conditions. A second member of the team is a Mercury medical doctor permanently stationed at Cape Canaveral on the astronaut's aeromedical team. In case of astronaut injury, this doctor will assume command of rescue operations. A third member is a McDonnell Aircraft Corporation spacecraft technician, picked because of his knowledge of spacecraft systems, ability to disarm any explosives and to get inside the spacecraft in the least possible time without injury to the pilot. Fourth team member is a Pan American driver of the vehicle. Fifth is a Pan American fireman for assisting in fighting spacecraft fires or, because of his first-aid knowledge, to aid the medical doctor if needed.

In the event of fire aboard the spacecraft during pad abort, the two Army vehicles will rush to the spacecraft, subdue flames with firefighting materials used through remote controlled nozzles to enable the rescue squad to reach the craft.

Astronaut self-egress from the Spacecraft is considered most desirable; it is quicker with less danger to fewer lives. However, since all eventualities must be foreseen, the rescue team is prepared to remove him from the Craft. The method of entering the Spacecraft from outside depends upon time availability. If the astronaut is incapacitated and must be removed immediately, the hatch will be blown from the outside. The hatch can be removed manually by a spacecraft technician if the mission is scrubbed. However, if the shot is called off after the umbilical cable drops away, time becomes quite critical due to loss of spacecraft cooling; thus, the hatch may be blown off by the astronaut or technicians before members of the rescue team ascend to the spacecraft to assist or to remove the astronaut.

The rescue team is in constant radio contact with the blockhouse and with helicopters deployed in and around the launch area. Therefore, their operation can be directed from either the blockhouse by the GD/Astronautics Test Conductor or by Lt. Colonel Harry E. Cannon, Cape Recovery Commander, from his helicopter.

Even if the spacecraft should land outside the launch area, the pad rescue team may be called upon to assist the Cape Recovery Team in places that might be inaccessible to Cape recovery equipment.

Maj. Cooper's Emergency Egress Committee, co-chairmanned by Hugh S. Herring, Atlas Co-ordinator for the Manned Spacecraft Center at the Atlantic Missile Range, constantly seeks to improve methods and equipment, and has incorporated every conceivable system to meet any emergency.

D:00-00-00 NS N:00 G.MER

WORD ONE/KEYSEARCH

International Cooperation
Aided First Orbital Flight
First US Man in Orbit
Part 1

Frutkin R20012

First U.S. Man in Orbit (Part 1)

INTERNATIONAL COOPERATION AIDED FIRST ORBITAL FLIGHT

By Arnold W. Frutkin

Mr. Frutkin is director of
International Programs for
the National Aeronautics and
Space Administration

WASHINGTON -- International cooperation was significant in the flight of the first U.S. man in orbit.

The well-being of the Astronaut depended on communications and tracking stations in various parts of the world. Governments in eight widely separated areas around the earth contributed their aid in this scientific project.

Mutually-beneficial agreements between the United States and the governments in these regions led to establishment of the stations.

There is nothing secret about the stations or their equipment. All are open to the public.

Citizens of these countries concerned helped build and staff the stations, in cooperation with United States personnel.

The stations, which contain equipment for direct conversation with the Astronaut and receipt of scientific information by radio from the spacecraft, are at:

- St. David's Island, Bermuda
- Maspalomas, Grand Canary Island
- Kano, Nigeria

- Zanzibar, East Africa
- Muchea, West Australia
- Woomera, South Australia
- Canton Island, Pacific Ocean
- Guaymas, Mexico.

There are also special tracking stations for the project on two U. S. ships at sea -- one in the Atlantic and the other in the Indian Ocean -- and at six points within the United States.

The main control station is at Cape Canaveral, Florida, where the Astronaut was launched. During his flight, information from all stations was transmitted instantly to computers at the Goddard Space Flight Center, Maryland, near Washington, D. C. All the stations are linked together by an around-the-world chain of communications.

Each station played a role in the space drama as the U. S. Astronaut circled the earth. Some citizens of the various countries heard the Astronaut's voice by radio as he whizzed through space far over their heads.

There are two different types of stations in the worldwide network of Mercury, the name of this first step in the U.S. project for man in space. All stations, including those at Nigeria and Zanzibar, are equipped for voice and information communication. In addition, some stations, containing very accurate radar, tracked the spacecraft through the skies from horizon to horizon.

Plans called for three orbits of the U.S. astronaut, each time over a different geographical area, with some of the stations able to contact him during only one or two passes of the craft overhead.

However, by using the entire network, controllers knew the precise location and condition of the spacecraft at every instant of its historic flight.

Without this exact location information, much of the scientific data obtained through the flight of the spacecraft and the Astronaut would have been difficult or impossible to interpret.

The desire of the various governments to assist in this peaceful scientific program is the reason for the cooperation provided to the United States man-in-space program. This international cooperation will result in benefits to science and the future betterment of mankind.

The U.S. decision to construct communications and tracking stations in other countries was made in 1959. During July and August that year, the countries concerned were informed about Project Mercury. Each country was asked if it would allow U.S. technicians to visit areas suitable for the stations. All the nations agreed, and assisted in the selection of appropriate sites within their borders.

To avoid radio interference from populated areas, the technicians looked for sites that were distant from cities and towns. They picked spots with unobstructed view, either on high or flat ground.

In the various countries, the land was surveyed between August 1959 and January 1960. Some of the Governments owned the land, and in other nations, it was private property for which the United States obtained options.

Actual negotiations for property began in November 1959 with several of the Governments. By February 1960, complete agreements were reached for the first two stations, both in Australia.

The Australian Government decided to construct and man its two stations using its own resources. Australian workers used local materials to build the stations. Despite the midsummer heat which reaches 126 degrees F (52 degrees C) at Woomera, that station was completed successfully.

Meanwhile, work was begun and pushed forward rapidly at all the other stations. The U.S. Government employed, through contractors, as many as 500 local inhabitants at one station, Zanzibar.

In all the countries, the people became friendly and hospitable to the U.S. technicians and other workers. In some countries, the U.S. men were able to take their wives and children to live with them. These families settled comfortably and became part of the local community.

Australian technicians were sent to the United States for training in how to operate the instruments and equipment. In other areas, local technicians studied operations right at the sites.

A special Mexican-United States commission was organized for the station at Guaymas, under the chairmanship of a Mexican scientist, Professor Mongez Lopez. The Government of Mexico contributed the land, built a concrete access road, and carried through a crash program to install communications lines.

The splendid cooperation throughout the entire international program was exemplified by the Emir of Kano, who once visited his station with 80 other Nigerian citizens. The Sardauna of Sokoto, who is also Premier of the Northern Region of Nigeria, was extremely helpful in establishing the station.

Since their station was completed, several distinguished Nigerian officials have visited rocket-launching sites in the United States, observed launchings, and have met the American astronauts.

To help technicians calibrate and test their radios, radar, and telemetering instruments, at the stations, U.S. contractors periodically flew aircraft over them in test runs. Local residents were invited to accompany these flights and sometimes flew in the planes as passengers, learning how the stations operate.

Officials of the various governments were informed in advance of all test flights of the Mercury spacecraft. During the orbital journey of the U.S. astronaut, the governments and people showed a personal interest in the flight.

The first successful test of the stations occurred on September 13, 1961, when the Mercury-Atlas IV spacecraft orbited the earth once. Then the Mercury-Atlas V spacecraft orbited the globe twice on November 29 to provide a full-scale rehearsal of the astronaut's flight.

U.S. scientists and members of the seven-man astronaut team worked at some of the stations during the flights. They had a chance to meet a number of local officials, who welcomed them warmly.

During future Mercury flights, the communications and tracking stations will continue to serve the interests of peace. They are joint scientific enterprises between the United States and the other countries concerned.

The training of people from these countries to work in the stations will also continue.

* * * * *

First U.S. Man in Orbit (Part 2)

PROJECT MERCURY SPACECRAFT IS COMPLICATED MECHANISM

by
James Upton

Mr. Upton is a writer of
articles on science, engi-
neering and medicine.

CAPE CANAVERAL, Florida -- The spacecraft flown by the first U.S. Astronaut in orbit is a complicated mechanism. Weighing about one ton (900 kilograms), its funnel shape measures nine feet (2.7 meters) long and six feet (1.8 meters) across the base.

Everything in the spacecraft is designed for the Astronaut's safety and efficiency.

During his epochal journey around the world, the astronaut was secured by safety straps to a form-fitting couch which supported his back, legs, and head. His gloved hands touched the two vital controls -- attitude handle and escape initiator -- but he often reached out to operate other devices.

In front of the Astronaut's face was the instrument panel, similar in some ways to the instrument panel in a modern airplane.

The Astronaut's eyes continually roved across the panel to check on such measurements as his cabin temperature and oxygen pressure.

WORD ONE/KEYSEARCH

D:00-00-00 NS N:00 G MER Project Mercury Spacecraft Upton R20012
is Complicated Mechanism
First US Man in Orbit
Part 2

spacecraft attitude in relation to the earth, fuel supply, and condition of batteries and other components.

For simplicity, a series of lights registered the condition of the most important systems at particular times of the flight. A green light meant proper functioning and a red light, improper. A handle next to each light allowed the Astronaut to correct failures.

In the event of a major failure, warning lights would have flashed on and a warning bell sounded, to alert the Astronaut to potential danger.

His spacecraft is airtight, watertight, and soundproofed, with walls strong enough to protect him from the hostile environment of space -- no atmosphere and sub-zero cold.

Altogether, the craft contained more than 10,000 components and seven miles (11.2 kilometers) of wiring.

In a normal sitting position, the Astronaut looked out through a window over his head and through a periscope at the bottom center of his instrument panel. Two automatic 16-mm motion picture cameras recorded his movements and the readings of the dials and instruments. A 70-mm camera took pictures of the earth and the sky.

Beneath the Astronaut was his environmental control system. This included his oxygen supply, a temperature regulator and a system for removing his exhaled carbon dioxide and other impurities from the cabin.

The Astronaut's communications facilities included high-frequency (HF) and ultra-high-frequency (UHF) radio transmitters and receivers; a

continuous-wave (CW) radio, and a special transmitter which automatically sent information to surface stations. Under ideal conditions, his HF radio signals could be heard 12,500 miles (20,000 kilometers) away, half-way around the globe.

One unusual radio receiver was connected directly to a number of his controls, enabling a command control station on the ground to direct his spacecraft to return to earth. This would have been used in an emergency, for example if the Astronaut had become unconscious.

Among the Astronaut's controls were compressed-gas jets on the surface of the spacecraft, designed to correct rolling, pitching, and yawing in flight.

The Astronaut sometimes manipulated these jets himself, and at other times allowed the automatic attitude controller to activate the jets. These jets were first used just after he went into orbit, to turn the blunt end of his craft from back to front. Thus the craft was pointed at all times in the proper direction for descent.

"Black boxes" contained complex, miniaturized electronics gear for automatic operation of the spacecraft. This automatic pilot (autopilot) system functioned to give the Astronaut time to make scientific observations and personal comments on his radio.

At the blunt or forward end of the spacecraft was an ablation shield which warded off the blazing heat of re-entry. Between the shield and the craft was a collapsed four-foot (1.2-meter) thick rubberized fabric skirt. This expanded after re-entry to cushion the craft's landing.

Much of the small end of the bell-shaped spacecraft contained parachutes and other recovery and rescue aids. These included a small drogue chute, a large main parachute and a reserve parachute for emergency use.

There were also smoke bombs and dye markers which were released automatically the instant the spacecraft landed. There was a package of metal "chaff" which was released just before landing, to allow recovery aircraft to find the spacecraft easier by radar.

At the top of the spacecraft was a large metal ring which the recovery helicopter used for lifting by cable. This ring is located off-center, so the spacecraft did not twirl around but hung slightly tilted beneath the helicopter.

A small inflatable rubber life raft was carried to enable the Astronaut to escape if his craft had sunk.

No single individual or group designed the original spacecraft. However, Maxime A. Faget, chief of Flight Systems Division of the National Aeronautics and Space Administration (NASA) did much original work on it. He first designed a blunt nose cone to withstand the blazing temperatures of re-entry. Faget and his team of engineers helped develop the control system, reaction jets and automatic pilot.

McDonnell Aircraft Corporation of St. Louis, Missouri, contracted with NASA to develop and build the Mercury spacecraft.

Scale models of the craft, one weighing 4,000 pounds (1800 kilograms), were dropped from high-flying aircraft and blasted into space during testing.

Some of these prototypes were dropped without parachutes to see how much punishment they would take. Others, containing delicate instruments, measured the various stresses and pressures that the Astronaut would have to withstand during his orbital flight.

"Abort" tests were conducted to assure that the spacecraft would remain in good condition after the escape rockets were fired to carry the vessel away from a simulated exploding booster rocket.

After all testing was successfully completed, two of the final models were used by Astronauts Alan B. Shepard and Virgil Grissom for their suborbital flights.

FIRST U.S. MAN IN ORBIT (PART 3)

Interview with Astronaut John H. Glenn Jr.

by
Robert Stevens

Mr. Stevens is
a writer of
science articles.

Shortly before U.S. Astronaut John H. Glenn Jr. piloted his Mercury spacecraft on its historic journey around the earth, I had the good fortune to be seated beside him on an airplane bound from Washington to Langley Field, Virginia, where he was in training. During the one-hour trip I had an opportunity to interview him about his imminent space journey.

What kind of a life did Astronaut Glenn lead while preparing to become the first U.S. man in orbit? Where did he go, what did he do, and what did he think about? These are some of the questions I put to Glenn.

"This is far from being an eight-hour-a-day job," Glenn told me.

"All the Project Mercury people are working long hours -- that's more or less normal at Manned Spacecraft Center at Langley Field. We Astronauts have quite a bit of reading and studying to do evenings, we rarely go home without a full briefcase."

Glenn has not used one day of leave in the past two years, although each Astronaut is entitled by law to 30 days a year. He called it "unusual" to have even a two-day weekend at home, in Arlington, Virginia.

WORD ONE/KEYSEARCH

D'00-00-00 NS N'00 G MER Interview with Astronaut Stevens R20012
John H. Glenn Jr.
First U.S. Man in Orbit
Part 3

"We Astronauts travel almost constantly," he said. "For example, later today I will fly to Pensacola, Florida, to do some refresher piloting there."

Several times recently he visited factories which manufacture Mercury spacecraft, Atlas boosters, and other equipment required in his orbital flight. During the final test flight of the Mercury-Atlas spacecraft on November 29, Glenn was an official observer at Cape Canaveral.

"The other Astronauts and I have just been back to the centrifuge at Johnsville, Pennsylvania," Glenn said. "We have continued training to leave the craft in the water. We just ran through the recovery procedures -- we have done this periodically for some time. We all swim a bit too."

The successful recovery of Glenn and his orbital spacecraft was to be far more difficult than recovery procedures during the previous suborbital missions because of the tremendous speed -- 5 miles (8 kilometers) a second -- with which his craft was hurtling through space.

"A timing error can throw the vehicle far off the planned impact point," he noted, "so there might be a longer wait for pickup. Also, the landing area is farther out in the ocean, with recovery forces deployed more widely."

Glenn was not worried about the minor difficulties encountered in the November 29 flight which was stopped after two orbits, instead of the three that had been planned for the chimpanzee Enos.

"With a man in the spacecraft in primary control, he can take corrective measures, unlike the chimp."

Glenn can speak as an authority on controls, because he was assigned in 1959 to work on the Astronaut's space layout inside the cabin. This includes controls, instruments, and other equipment.

"Each of the Astronauts is still following his special area," he remarked. "We weren't particularly specialists in these fields when we started, but we all had past engineering experience. Each of us monitors one area and reports back to the other six. We have all recommended various changes in the spacecraft."

Just before his flight, Glenn spent some time in the "procedures trainers" at Langley Field and Cape Canaveral, using full-scale models of the spacecraft to simulate space missions. He concentrated on the automatic and reaction control systems and the environmental controls, for oxygen and temperature regulation.

Temperature control was particularly vital in his orbital flight.

"There is much more heat and energy to dissipate, compared to the suborbital flights," he explained. "The spacecraft travels about 18,000 miles (28,800 kilometers) an hour in orbit and the friction from the atoms during re-entry causes difficult re-entry problems."

Glenn pointed out another crucial difference between suborbital flight and his own trip into space.

"The suborbital flights at about 5,000 miles (8,000 kilometers) an hour have a 'loft' trajectory, like throwing a ball into the air. The cutoff speed and angle of the booster do not have to be extremely accurate. But going into orbit, the craft must hit an exact spot at a certain speed

and angle, with a precise power cutoff. Otherwise it will not go into orbit, or it may go into the wrong orbit. After cutoff, the craft keeps a balance between gravity and its centrifugal force."

He added: "In every way, the orbital flight must be a closely controlled maneuver. The tracking network gives the exact time of retro-fire, to bring the craft down at the correct landing site."

Plans for voice communications by radio are extensive and Glenn was able to receive and transmit information to every station in the network.

Glenn and the other Astronauts have not changed their regular training drastically since May 1961 when Astronaut Alan Shepard made his suborbital flight. His physical preparations -- large breakfast, etc. -- for the orbital flight were to be about the same as those made by Shepard, Glenn said. Eating and drinking in orbit also was part of the flight plan.

Were plans made to cover all eventualities during the trip?

Said Glenn: "We hope we have foreseen all the unknowns, but undoubtedly we will learn much. In any experimental flight, we never know all the answers. If we did, there would be no point in going."

"This is space exploration, and also exploring human limits. We plan to determine what man can and cannot do, for future missions and for building future spacecraft."

* * * * *

First U.S. Man In Orbit (Part 4)

ASTRONAUT JOHN H. GLENN JR. -- PROFILE

It is easy to see why 40-year-old John H. Glenn Jr. was selected to make the United States' first orbital flight.

The athletic but studious volunteer is a striking combination of the qualities of skill, fitness and dedication which have become the standard for America's hand-picked body of space-age pioneers.

Fascinated by the challenge of aviation since childhood, Glenn has developed himself into a remarkable blend of the daring flyer and the carefully balanced student of modern space science. At the climax of his career, the veteran pilot is close to being the ideal answer to the long search for a man whose physical and mental attributes harmonize almost perfectly with the precise and complicated machinery designed to place him in orbit.

Although the oldest of America's seven-man Astronaut team, the red-haired, studious Glenn keeps himself in top physical condition by running two miles each morning before breakfast. His years of experience in all types of aircraft have given him a high degree of technical ability -- as well as a relaxed, confident appreciation of his capacity to meet any emergencies which may arise.

At the same time, the lean, muscular Glenn is far from being a one-sided personality whose only interest is in machines. A devoted

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family-man and the father of two teen-age children, America's No. 1 Astronaut is deeply religious (he is a Presbyterian) and has devoted much thought to the relationship of his career to the principles of his faith. To the fullest extent possible, Glenn shares his space experiences with his wife Anna, his children John David and Carolyn Ann and other members of his family.

Keenly aware that his selection to make his country's first attempt at orbital flight placed him on the threshold of a great adventure, Glenn has nevertheless conducted himself with modesty despite the widespread publicity he has received.

Being America's "first true space man," he once said "Is something we Astronauts feel very strongly about. We are trying to more or less play down the idea of who will be the first man. We feel that we are all extremely fortunate to be present at this time in history, where we can take part in such a big venture as this. We feel that is much more important than whose name happens to be on the first ticket to go."

His own achievements, as well as the feats of his fellow Astronauts, Glenn says matter-of-factly, should be regarded merely as "stepping stones" in the continuing venture of man's ultimate conquest of space.

How did Glenn qualify for his assignment?

The story begins in the small town of Cambridge, in the mid-western state of Ohio, where Glenn was born July 18, 1921. By the time

he was six years old, his green eyes sparkling with an interest foretelling his later achievements, young Glenn had seen enough of airplanes to know that he wanted to make flying his life.

This interest was maintained through his school years and three years of study at Ohio's Muskingum College until Glenn's real flying career began with his service as a Marine Corps pilot in World War II. For outstanding performance in flying the aircraft of that day in dozens of missions in the Pacific and later over Korea, Glenn was awarded five Distinguished Flying Crosses and seventeen Air Medals. When peace came, Glenn served as an instructor in advanced flight training and was closely associated with the development of new types of planes. He is a graduate of the U.S. Navy's Test Pilot school and has had specialized training at the University of Maryland and in other schools. In 1957, Glenn became the first man to cross the United States at a speed faster than sound, making the jet flight from Los Angeles to New York in three hours and 23 minutes.

Now a Lieutenant Colonel in the Marine Corps, Glenn has had more than 5,000 hours of actual flying experience in various types of aircraft and in all kinds of conditions, a background which he believes is of special value in his new career as an Astronaut. "The space traveler," he says, "needs a confidence only experience can give him... Experience in dangerous and unexpected situations is even more valuable than good conditioning."

Since his selection in April 1959 as one of the seven Astronauts to train for space flights under the National Aeronautics and Space Administration's "Project Mercury" program, Glenn has been a key figure in America's preparations for orbital flight. He has engaged in strenuous conditioning and training activities for more than two years and was the "back-up" or reserve pilot for the sub-orbital flights made earlier this year by Commander Alan B. Shepard Jr. and Captain Virgil L. Grissom.

As early as December 4, 1961, Glenn had moved into special "ready room" quarters for the final stage of his intensive preparations for the big adventure in actual space flight.

Despite his unassuming modesty, Glenn makes no secret of his confidence in his own ability -- or of his sincere appreciation of the opportunity he has been given. He has observed that the whole Project Mercury program is comparable in many ways to the historic efforts of the Wright brothers in making the first flight in a heavier-than-air machine early in this century. "I think," he said recently, "that we stand on the verge of something big and expansive."

Speaking for all seven U.S. Astronauts, Glenn added: "We are looking at the beginning of manned space flight really as a tremendous exploration, probably the greatest exploration that man has ever undertaken. And we are fortunate enough to be here at a place and time where we can take part."

As for himself, Glenn has repeatedly said that he has no illusions "about being any hero or superman. I am pretty much the same man I have always been -- except that I have had a few more experiences than before."

Glenn made one more observation. "This is not a stunt in any sense of the word," he said quietly. "We are trying to conduct the whole mission so that it is the first step....a solid scientific foundation for missions to come."

First U.S. Man in Orbit (Part 5)

SEVEN ASTRONAUTS WERE NEEDED FOR SEVEN VITAL JOBS

by
Edwin Diamond

Mr. Diamond is a
general editor of
Newsweek magazine.

CAPE CANAVERAL, Florida -- All eyes were on Lieutenant Colonel John H. Glenn Jr., the 40-year-old Astronaut chosen as the prime pilot, as the long countdown neared its final moments for the Project Mercury's first orbital flight.

Glenn's compact, 170-pound frame was encased in his silvery aluminum-nylon pressure suit. He eased into the close confines of the Mercury spacecraft, adjusted the restraining straps on the contour couch, and watched as the hatch was bolted shut.

As he embarked on his epochal journey, the ride was a solitary one. Yet, in a real sense, it was also a joint endeavor in which thousands of men took part. In this overall effort, each of the other six Astronauts had a task that was vital to the mission.

Next to Glenn's assignment, the most important task had been given to Malcolm Scott Carpenter, the 36-year-old Navy Lieutenant commander who was the "back-up" pilot. Carpenter went through most of the early countdown with Glenn.

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Seven Astronauts Were Needed Diamond R20012
For Seven Vital Jobs
First U.S. Man in Orbit
Part 5

They were both awakened early, shared breakfast together, underwent physical examinations, put on their spacesuits, and rode together in a special van to the launching pad. This back-up procedure is a standard part of all manned spaceflight countdowns. The object is to have a well-qualified second pilot ready to step in should the "prime" Astronaut become ill or otherwise disqualified.

Also accompanying Pilot Glenn to the launching site was Navy Commander Alan B. Shepard Jr., who made the first suborbital flight in the Mercury program. His role was pilot instructor. It was his responsibility to run through various phases of the mission with Glenn.

For example, the pair reviewed the latest weather reports so that Glenn could play an active role as meteorological observer in flight. Shepard also flashed special star charts before Glenn's eyes, helping him memorize the locations and characteristics of the chief astronomical bodies he later viewed.

Once the hatch was bolted and the huge gantry rolled away from the Mercury-Atlas vehicle, Glenn talked via his headset with CAPCOM -- capsule communications monitor in the Mercury central control room. CAPCOM had been assigned to Astronauts Donald Slayton, 37, or Walter Schirra, 38, two men with a large stake in Glenn's mission. Slayton is the prime pilot and Schirra is his back-up for the next manned orbital flight. During the critical first minutes of powered flight, CAPCOM kept in voice communications with Glenn.

There were three other key assignments during the flight, fulfilled by Astronauts Virgil I. Grissom, LeRoy G. Cooper Jr., and either Schirra or Slayton.

One of the Astronauts flew the "chase" aircraft, a supersonic jet which was airborne when the countdown reached zero. He was assigned to fly past the climbing rocket at approximately 35,000 feet. Since this is the altitude where the rocket sustained maximum aerodynamic forces, the chase pilot was in a position to observe how the rocket behaved.

Another Astronaut was assigned to a key tracking station, one of many scattered around the globe. The third Astronaut was with the seaborne recovery forces in the Atlantic Ocean off Bermuda. As soon as the mission was completed and Glenn boarded the Navy ship, the de-briefing began. This process was designed to cover every detail of the flight. Glenn talked into a tape recorder, giving all his first impressions of his memorable journey through space.

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First U.S. Man in Orbit (Part 6)

MALCOLM SCOTT CARPENTER -- PROFILE

The opportunity to become the United States' pioneer orbiting spaceman was the answer to one of Malcolm Scott Carpenter's fondest dreams.

Throughout more than two years of intensive study and training, the 36-year-old Navy flyer never lost sight of this potential reward for his dedication to the task of making himself 100 per cent fit for the exacting challenges ahead.

Like the other six hand-picked American Astronauts, he has given virtually single-minded attention to the Project Mercury program since his selection in early 1959. Carpenter was confident that sooner or later his chance would come. He was determined that he would be ready when the big day arrived.

As a matter of fact, Carpenter's whole life seems to have been spent in conscious or unconscious preparation for his role as spaceman.

As a boy in the high mountains of the western state of Colorado, Carpenter developed a strong body and quick reflexes by years of hiking and skiing in some of America's most rugged surroundings. Immediately after finishing his secondary school studies in 1943, the Astronaut enlisted in the U.S. Navy as an aviation cadet and began his life's work as a flyer.

Leaving the Navy temporarily at the end of World War II, Carpenter earned a degree in aeronautical engineering at the University of Colorado.

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Malcolm Scott Carpenter NS R20012
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He then returned to the service for more flight training and duty as an active pilot in the United Nations' defense of Korean independence.

In the years since, Carpenter has served as a Navy flight officer at sea, studied communications and electronics and perfected his piloting skills by flying and testing many types of aircraft. When space officials began their difficult task of selecting the best qualified American aviators for Project Mercury, Carpenter was a stand-out candidate.

At five feet 10 1/2 inches (179 centimeters) tall and 155 pounds (70.3 kilograms) in weight, the well-knit, broad-shouldered Carpenter passed all the mental and physical tests with flying colors. His instant reactions to emergency situations and his ability to meet conditions of the severest stress with relaxed competence made his choice a certainty.

Like all six of his fellow Astronauts, Carpenter is a family man whose wife and children are seldom out of his thoughts. As Mrs. Carpenter says, "Scott is so intensely devoted to our four children that he scarcely takes his eyes off them during their precious hours together."

In 1951, Mrs. Carpenter adds, "our six-month-old son Timmie died. Scott's faith in God and his own incredible strength brought us through this tragedy and it probably made Scott more conscious of his role as a father than most men."

The relationship between Carpenter and his wife is particularly close, Mrs. Carpenter having shared her husband's work and ambitions from the beginning of their life together. This pattern of mutual discussion became an integral part of the Carpenters' existence in the first year of

their marriage, spent in a small house deep in the Colorado mountains, where the couple had no close neighbors. In those days, as Carpenter chopped wood for cooking and heating and completed his university studies, the couple formed their present habit of discussing their problems as a team.

The United States' pioneer man in orbit was overjoyed with the opportunity to join the Project Mercury program, particularly since he had feared that an impending Navy assignment would remove him at least temporarily from his beloved flying duty.

Carpenter regards his participation in the conquest of space as considerably more than an opportunity to satisfy his personal ambitions. Few men, he says soberly, have the chance to take part in pioneering "on such a grand scale...This is something I would willingly give my life for, and I think a person is very fortunate to have something he can care that much about."

Carpenter's special area of study (each Astronaut specializes in one phase of space travel and is responsible for keeping his fellow volunteers up to date on his findings) has been navigation and communications. His skill in these fields stood him in good stead on his historic flight, helping him materially in maintaining a constant check on his Mercury craft's position and keeping in precise radio contact with surface tracking stations which monitored each second of his orbital journey. This skill also helped him make necessary corrections to assist his craft's successful reentry into the atmosphere and to guarantee its landing in the designated area.

Carpenter's associates in the space program have been impressed from the beginning with the Astronaut's poise in the most dangerous and taxing phases of the Mercury conditioning and training effort.

His greatest comfort, however, came from his complete faith in everyone associated with the flight. As Carpenter commented: "I believe we have the best minds in the country behind this project."

First U. S. Man in Orbit (Part 7)

PROJECT MERCURY -- FIRST U.S. MAN IN ORBIT

by
James E. Webb

Mr. Webb is Administrator of
the National Aeronautics and
Space Administration

WASHINGTON -- When the first U.S. Astronaut embarked on the Project Mercury orbital flight, it was the culmination of an experiment conceived and executed on a grand scale.

The Astronaut orbited the earth in a blunt, wingless one-ton spacecraft shaped like a bell. A multiple communications network linked him to 16 earth-based monitoring stations on his orbital flight that spanned North America, Africa, Australia, and the Atlantic, Indian, and Pacific Oceans. Radio and radar, telephone and teletype, leased landlines and overseas radio and cable facilities kept the entire world informed of the spacecraft's position and the Astronaut's condition.

At a typical station, a physician checked the Astronaut's heartbeat, respiration, blood pressure, and body temperature simultaneously by observing the data automatically transmitted from the spacecraft by radio.

Similarly, engineers at the station monitored the technical phases of the flight.

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First US Man in
Orbit Part 7

Less than three years ago, the U.S. had neither the spacecraft, the men trained to pilot it, nor the ground-based tracking and communications network to make manned space flights worthwhile scientific ventures. Project Mercury came into being under the auspices of a newly-created civilian agency, the National Aeronautics and Space Administration (NASA) in October 1958.

The chief features of the spacecraft -- the steeple-like escape tower, the use of retro-rockets for slowing the craft to cause it to re-enter the atmosphere, the blunt, "high-drag" shape to protect against the friction heat of re-entry -- represented direct and effective engineering solutions to the problem of space flight.

At the same time the spacecraft was taking shape, a score of other necessary items of equipment were being developed. There was, for example, the problem of outfitting man for the hostile environment of space. A new lightweight aluminized nylon spacesuit was designed to protect the Astronaut in the event of a calamitous pressure leak. Yet the suit provides mobility so that the Astronaut can attend to his flight chores.

Soon after Project Mercury was begun, seven carefully screened test pilots were selected by NASA. During the past 32 months, these Astronauts have been trained for the task of piloting the Mercury spacecraft. Although engineers as well as pilots, the seven Astronauts were given additional intensive instruction in such basic aerospace subjects

as aviation medicine, astronomy, meteorology, and astronautics (including ballistic trajectories, fuels, and other aspects of modern rocketry).

As far as possible, the Astronauts were trained in the environments of space flight duplicated in laboratory experiments. Whirling centrifuges subjected the Astronauts to the forces of rocket acceleration. Weightlessness was experienced for brief periods in flying aircraft. In tiny chambers, darkened and soundproofed, the Astronauts simulated the cramped isolation of orbital flight in space.

The engineering, equipment, and Astronauts proved their value in a total of 19 test-flight missions. The most spectacular were the suborbital flights of Astronauts Alan B. Shepard and Virgil I. Grissom.

The first successful manned orbital flight in the Mercury program is not an end but a beginning. The spacecraft, and most important, the Astronauts themselves, will fly again and again.

Following this first manned orbital mission, the Astronauts will steadily extend and expand the U.S. exploration of space. During 1962, for example, there are plans for an orbital flight approximately every two months. The Mercury flights will be extended to 18 orbits or 24 hours in duration.

After that will come the program to fly the Apollo spacecraft which will carry three men. Project Apollo has three phases designated A, B, and C.

Riding atop an eight-engine Saturn rocket with a thrust several times greater than that of the Atlas, the crew of Apollo A will go on a week-long earth orbit in about 1964. Apollo B and its crew will make

flights around the moon in about 1965. They will select, among other things, likely landing sites for the crew of Apollo C, which will make a lunar landing in the last years of the decade.

Much of the engineering knowledge and systems concepts worked out for Mercury will be incorporated in Project Apollo. For instance, the same tower-like escape rocket, designed to wrench the spacecraft away from the booster rocket in case of a catastrophic failure on the launch pad or during the first minutes of powered flight, will be adapted to Apollo.

Several Apollo spacecraft shapes being considered make use of the Mercury configuration for the critical moments of re-entry. The Apollo no doubt will return to earth with its blunt end forward in the same manner as the Mercury spacecraft.

The Mercury "contour couch" concept will be repeated so that there will be an individually fitted couch for each of the Apollo Astronauts.

Suit design, environment control, reaction jets for steering in space, and other Mercury features may also be used in Apollo.

Perhaps the most valuable asset of the Mercury program to be available to Apollo will be the experienced Mercury Astronauts. They already have qualifications difficult to match.

Therefore, the mid-60s may find these seven men, then in their forties, serving as Apollo spacecraft commanders to a crew of new-generation Astronauts.

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THE FUTURE OF MANNED SPACE FLIGHTS

by
D. Brainerd Holmes

Mr. Holmes is Director of
Manned Space Flight Programs,
National Aeronautics and Space
Administration

LANGLEY FIELD, Virginia -- Man is in space to stay. There he is destined to play a vital and direct role as both pilot and scientific observer, as the U.S. Astronaut did in his orbital flight.

In the past, questions have been raised about the dual roles -- pilot and scientific observer -- the Astronaut plays. Some scientists have argued that anything a man can do, can be done as well or better by instruments -- and without all the equipment needed to keep the man alive.

The problems of sustaining man in space are, of course, well known. He is, in some ways, a fragile creature. He depends on oxygen and an exquisite balance of pressures and temperatures. He must be protected. He cannot do monotonous work for a long time. He is fallible and he is unable to perceive many things which instruments can detect.

But instruments also require a degree of protection; they also malfunction. True, provision can be made for "backup" devices to take control in case of failure, but the added weight and complicated electronic devices create even more problems.

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Man, on the other hand, is flexible and imaginative. He can observe, reason, and make decisions. The human brain is its own "backup."

The Project Mercury program has demonstrated clearly that the issue of man versus machines is incorrect. It is not man versus machines but man plus machines.

In the Mercury spacecraft, for example, there are parallel systems for every phase of the flight. The entire mission can be controlled automatically by radio signals from ground stations. Alternatively, there are manual controls or "over-rides" which the Astronaut can use at his discretion. The automatic systems work to the Astronaut's advantage, freeing him for other tasks.

At the same time, the manual controls provide both a simpler and thus more reliable system and a backup or reserve system.

As the range and duration of space missions increase, flights will be measured in days and weeks rather than in minutes and hours. The Astronaut will necessarily want to leave routine attitude control to automatic equipment and concentrate on scientific observations, reports, and experiments.

During 1962 and 1963, Project Mercury envisions sending men on orbital flights for a full day and night. Beyond Mercury, there is the Apollo program with plans for week-long missions around the earth. Early Apollo flights will have two and three-man crews.

They will be able to use their spacecraft as an orbiting astronomical observatory to study the stars and planets with unparalleled clarity,

since they will be above the atmosphere, which distorts the vision of earthbound astronomers.

They will conduct invaluable experiments in the "hard vacuum" of space. They will be able to determine the effects of long periods of weightlessness on human beings.

Present timetables call for the Apollo crewmen to perform their tasks about 1964. Later Apollo flights will take man still farther into space -- and call on him to perform more complex tasks.

On May 25, 1961, President Kennedy proposed, and Congress endorsed, a U.S. goal of landing men on the moon before this decade is over. The National Aeronautics and Space Administration (NASA) is working with the help of other government agencies to achieve that goal.

The first man on the moon will survey a bleak domain. Since there is no atmosphere to screen out solar radiation, the lunar explorers will have to wear protective suits at all times.

The absence of an atmosphere, however, makes the moon so attractive as a place for scientific observations by man. As Dr. Robert Jastrow of NASA has pointed out, the history of the solar system is preserved on the face of the moon.

On earth, the erosion by wind and water and the upthrust of mountains and volcanoes have wiped out the original surface. But the pristine surface of the moon -- observed first-hand by men -- can help astrophysicists reconstruct the birth and early life of the solar system.

With these objectives, the crewmen may spend their first hours of exploration on the moon as geologists. They will collect soil samples, take seismic profiles, and photograph important lunar outcroppings.

For the first time, man will be able to examine his own physiology away from his mundane surroundings. Since lunar gravity is only one-sixth that of earth's, the performance of the human body will be of particular interest.

Almost free of gravity and all the usual environment associated with living on earth, men are certain to learn more about themselves.

But these practical and scientific advantages are not the chief reasons that propel man outward into space. The motivation for manned space flight goes deeper. Throughout history, man's destiny has compelled him to explore the unknown, scale every summit, overcome every obstacle.

The means to reach the moon are almost within man's grasp. But this will be only the beginning. Beyond the moon are the planets of this solar system and then other solar systems.

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First U.S. Man in Orbit (Part 9)

TRACKING THE FIRST U.S. MAN IN ORBIT BY RADIO AND RADAR

by
Christopher C. Kraft Jr.

Mr. Kraft is Assistant Chief,
Flight Operations Division,
National Aeronautics and
Space Administration

LANGLEY FIELD, Virginia -- The first U.S. man in orbit flew too high for his spacecraft to be seen with the naked eye. Even powerful telescopes could not accurately follow his speedy flight.

Therefore, the U.S. relied on radio and radar to track the astronaut's global trip and thereby assure his safety.

Tracking and communications stations were established on all parts of the earth under the flight path to guide the Astronaut on his journey. He conversed with men on the ground by two-way radio. They traced the path of his spacecraft on radar scopes. Their data was used to determine the exact spacecraft position.

While the Astronaut was circling the earth, communications systems specialists and physicians on the ground listened by radio to the astronaut's voice. Automatic instruments in each station also received data by "telemetry" (measuring by radio) on the Astronaut's breathing, temperature, and pulse, for permanent records.

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Tracking The First
U.S. Man in Orbit by
Radio and Radar
First US Man in
Orbit Part 9

Kraft R20012

Among the 90-odd types of measurements recorded at the stations were temperature and oxygen pressure of the spacecraft cabin, pressure in the Astronaut's spacesuit, battery voltages, and the Astronaut's handling of the many controls.

All this information was flashed as soon as it was received from space, via automatic communications lines, to control headquarters at Cape Canaveral, Florida. There, scientists and computers quickly evaluated the data to assure that the flight was progressing as planned. They followed the Astronaut's route on a huge world map stretched across an entire wall.

If anything had gone wrong with the spacecraft or if the Astronaut's life had been endangered by the flight, personnel at the control center would have known it almost at once. They could then have taken immediate steps to attempt to correct any malfunctions.

Using their worldwide communications network, they would have informed the Astronaut and the other tracking and communications stations of any abnormal circumstances. If necessary, the astronaut or a control station could have cut short the flight at any time.

The fact that the flight was successful is due in part to the excellent work done at the tracking stations. The close-knit bond between men and machines enabled the Astronaut to complete his journey safely.

The global instrumentation network with its split-second communications has four main functions:

1. Tracking -- to let us know the exact location of the spacecraft at all times.

2. Communications and telemetering -- to let us know in detail what is happening within the spacecraft.

3. Command control -- to enable us to control the spacecraft from the ground, under certain conditions.

4. Coordination -- to enable us to communicate with the Astronaut and all ground stations, from launch until recovery.

Tracking the Astronaut began at the moment the huge Atlas rocket blasted off the launching pad at Cape Canaveral. These first few minutes were the most crucial ones of the flight.

The tracking station at Cape Canaveral and another large one at Bermuda had their complicated radar equipment aimed directly at the Atlas. They helped determine whether it was following the correct flight path.

As the Astronaut went through his checklist during blastoff, he told the ground personnel by ultra-high-frequency (UHF) radio how he and his instruments were responding.

At the same time, ground personnel examined the telemetry reports from the spacecraft.

Complex computers in both the U.S. and Bermuda calculated whether the spacecraft went into its proper orbit. Both stations would have known almost immediately if the proper orbit had not been achieved. In either case, or if there had been a spacecraft malfunction or pilot difficulty, both stations could have ordered the mission aborted, and begun a safe

re-entry maneuver. The spacecraft would then have returned to earth earlier than had been planned.

Radar at Grand Turk and Grand Bahama islands caught the image of the spacecraft on radar scopes as it passed overhead. Next, a specially-fitted U.S. ship in the mid-Atlantic Ocean took over the communications duties for a few minutes, then passed the chore to the Canary Island station.

The Astronaut radioed information to these stations and they replied.

If the spacecraft had not entered orbit correctly, it would probably have landed in the Atlantic Ocean, some distance from the Canaries. In this event, the station there would have provided re-entry and recovery data to the Astronaut and recovery ships.

Since all went well, the Astronaut next talked to the stations at Kano, Nigeria, and Zanzibar, East Africa, both of which have radio and telemetry equipment.

After the Astronaut lost contact with Zanzibar station, he conversed with the far-distant U.S. ship in the Indian Ocean. He was able to use his UHF radio as he sped over the ship, then he switched again to HF to listen for the first Australian station.

Radar at Muehea and Woomera, Australia, tracked the spacecraft across almost the entire continent. Muehea station is approximately 180 degrees, or half-way around the globe, from Cape Canaveral. Tracking data from Muehea were used to calculate the maximum observed differences between the planned and actual orbital paths.

The Astronaut was out of contact with the surface stations for a few minutes as he started his long flight over the Pacific Ocean. He was able to try his continuous-wave (CW) radio, tapping out Morse code on a telegraph key and listening for the replies.

His next checkpoint was Canton Island in mid-Pacific where telemetry and conventional radio equipment were used again.

The Hawaii station was too far away to track the spacecraft during this orbit, but was standing by for the second orbit, as was the station in California.

As the spacecraft approached the station at Guaymas, Mexico, the astronaut knew that he would be tracked all the way across North America. As he traveled across the United States, he was picked up by stations in New Mexico, Texas, and Florida.

Thus the Astronaut was in direct contact with the ground stations through approximately 90 percent of his time spent in space.

By means of the worldwide network of stations, information was sent back to Cape Canaveral in "real time," that is, at essentially the same time that events were occurring in the spacecraft.

Because of this speed of transmittal, the computers were able to predict the path of the spacecraft. In this way, radar stations could be told moments in advance at precisely what angle to point their radar antenna, to "look" for the craft.

If anything had gone wrong with one of the means of communication between stations -- radio, telephone, or teletype -- the operators could have switched instantly to alternate circuits.

The Astronaut's journey has proved the efficiency of the world-wide communications network. Now scientists can look forward to using this and similar networks during future flights around the earth, and perhaps even in flights to the moon and planets.

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First U.S. Man in Orbit (Part 10)

THE SPACECRAFT'S SAFETY SYSTEM

by
Maxime A. Faget

Mr. Faget is Chief, Flight
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Aeronautics and Space Ad-
ministration

LANGLEY FIELD, Virginia -- One of the most distinctive features of the Mercury spacecraft occupied by the first U.S. Astronaut to orbit the earth was a steeple-like, 16-foot-long escape-rocket tower attached to the top of the craft. This was for the Astronaut's safety during the launching of his Atlas.

The hope was, of course, that this escape system would never have to be used. Every attempt was made to assure not only the success of the mission, but, above all, the pilot's safety. However, all mechanical equipment is subject to malfunction. The escape-rocket tower was thus an important bit of insurance built into the overall system. It was, in effect, a small "getaway" rocket available for use if there was some catastrophic trouble in the main booster rocket.

Consider the Astronaut's position during the long countdown before rocket ignition, then during launching, and finally in the first 150 seconds of powered flight through the atmosphere:

WORD ONE/KEYSEARCH

D:00-00-00 NS N:00 G:MER The Spacecraft's Safety System. First U.S. Man in Orbit Part 10 Faget R00012

He was strapped on his back to a contour couch within the close confines of his Mercury spacecraft. The hatch was closed and bolted. Beneath the craft was the huge lifting rocket.

For the orbital flight, a liquid-fueled, three-engine Atlas rocket was used. Two vernier engines are also on the Atlas. Fully loaded, the Atlas holds almost 100 tons of kerosene rocket propellant and liquid oxygen oxidizer.

At this point in the countdown, only an explosion of this fuel supply would require escape from the vehicle. Other malfunctions, for example, in the guidance system, in the electric power units, or in the hydraulic system, would merely delay the countdown.

Because the propellant materials are potentially volatile at any time, they were monitored by engineers stationed at the blockhouse consoles. If any of a score of sensors had detected an impending explosion in the Atlas during the countdown, the escape system could have been fired by a signal from the blockhouse or by a signal from the Astronaut in the cabin.

After liftoff, a completely automatic emergency sensing system named Abort Sensing and Implementation System (ASIA), could have given an electric signal that warned in advance of possible major trouble. This warning could have been of not only a booster explosion but also of unacceptable deviations in the direction or attitude of flight, excessive turning rates, loss of rocket thrust, or failure of the electric power.

When the escape rocket system must be fired, either during the countdown or during the powered flight, the following sequence begins in a fraction of a second:

1. The clamp ring which attaches the spacecraft to the rocket is released by explosive bolts and the retro-rocket package fastened to the spacecraft heat-shield is jettisoned.

2. The escape rocket, a solid-fuel canister, is fired. The thrust of this rocket is enough to pull the spacecraft safely away from the Atlas.

In the pre-launching situation, the escape rocket is powerful enough to lift the craft higher than 2,000 feet (610 meters) and well to the side of the launching pad. If it is triggered during powered flight, it takes the craft and Astronaut away from the fireball of the burning fuel and oxidizer.

3. After the spacecraft is well clear of the Atlas, explosive bolts are fired to release another clamp ring which holds the escape-rocket tower to the craft. A second, small rocket mounted beneath the escape rocket on the tower begins thrusting to carry the tower (and the now-spent escape rocket) away from the spacecraft. This clears the way for deploying the parachutes from the upper end of the craft.

4. After the tower is clear, a six-foot drogue parachute is deployed. This chute stops any rotation of the spacecraft. Then the main 63-foot-canopy parachute deploys and the heat shield is released. This, in turn, extends the landing-impact bag which forms a pneumatic cushion to dissipate the shock of landing. (The bag is needed primarily for ground landings on or near the launching pad, but it is also valuable for sea landings if wind or waves are high.)

During a normal flight, the escape tower is jettisoned when it is no longer required as a safety device. This happened in the flights of Astronauts Alan Shepard and Virgil Grissom. Engineers expect the same to be true of future flights. But they have provided the Astronaut with a way out in the event of any emergency.

First U.S. Man in Orbit (Part 11)

TRAINING FOR THE FLIGHT

by
Lieutenant Colonel (M.D.) Stanley White, U.S. Air Force
and
Dr. Robert B. Voas

Dr. White is Chief, Life Sciences Division, and Dr. Voas is a psychologist, both in the National Aeronautics and Space Administration

LANGLEY FIELD, Virginia -- America's first Astronaut to orbit the earth achieved another giant stride forward in the United States' step-by-step program to explore space for the peaceful benefit of all mankind. Each step adds to man's understanding of the vast universe surrounding the earth.

This flight was made possible by months of planning, inventing, experimenting, building and training. The Astronaut who guided this first U.S. orbital flight trained more than two rigorous years preparing for the little time he spent in the flashing Mercury spacecraft. The training course for him and his six fellow-Astronauts was divided into five major categories. They were:

Academic or scholastic

With static training devices

With dynamic, or moving, training devices

WORD ONE/KEYSEARCH

D:00-00-00 NS N:00 & MER Training for the White R20012
Flight. Voas
First US. Man
in Orbit Part 11

Spacecraft egress or escape and survival

Specific mission training.

Most of the devices used in this training provided one thing in common: the feeling of confidence the Astronaut achieved from their use.

The course in academic subjects brought the seven Astronauts up to date in the sciences, basic mechanics and aerodynamics. All seven had university degrees in engineering or one of the basic sciences. Each was a qualified jet pilot and a graduate of test pilot school. However, they needed review in such fields as astronomy, meteorology, astrophysics and geophysics. Instructors gave them a series of lectures covering these subjects.

One physiology talk was a detailed description of the human anatomy and the effect caused by various stresses -- such as the heavy gravity (G) forces created by acceleration and deceleration.

Engineers building the Mercury spacecraft and its various subsystems gave the Astronauts continuing briefings, keeping them up to the minute with design, progress and changes. They took many field trips to the industrial plants and test facilities where they observed at first hand the mechanics of building, testing and assembling. As a result of these visits, the Astronauts were able to recommend changes and incorporation of such things as cockpit layout and instrument panels.

In the static training devices, including one which almost completely simulated the Mercury control cabin, the Astronauts learned

procedures for controlling the spacecraft in actual flight. Guided by an instructor who followed their movements on a remote-control console, they became accustomed to the Astronaut's couch. They practiced retro-rocket firing, re-entry maneuvers, attitude control for pitch, roll and yaw, and troubleshooting for instrument failures. On the ground they duplicated actual flight profiles which later would be performed in space. Using a periscope and a moving screen, they practiced celestial navigation around the "earth."

The third category of preparedness was with the dynamic trainers. Since no way has yet been devised of simulating weightlessness on the ground, they went through this experience in the parabolic flight of various aircraft. They ate food and drank water in the brief moments of the weightless period.

The Astronauts went through the ordeal of high G-forces in a human centrifuge, a device wherein a gondola is mounted at the end of a long revolving arm. Some of these tests carried them to 18 G-forces, even higher than that expected during orbital flight. In a device called a multiaxis spin test inertial facility, a seat was mounted within a frame which could be rotated at 30 revolutions per minute on three axes simultaneously. The device provided an extreme test of control skill under tumbling conditions.

All the Astronauts regularly flew the most modern U.S. jet aircraft to maintain their pilot proficiency.

One of the primary requirements in formulating the Mercury program was the safeguarding of the Astronaut in every way humanly possible. Provisions were included at every stage of the orbital flight for his escape in case of mishap.

Reflecting this concern for his safety was the egress and survival training program carried out by the Astronauts. They practiced leaving the Mercury spacecraft in the actual rough waters of the Atlantic Ocean, both through the narrow neck of the craft and by using the escape hatch. They conducted survival tests with the one-man raft which is part of the Mercury equipment. They learned to survive in the uninhabited desert, in the remote possibility of landing there.

The fifth training phase for the Astronauts covered some eight weeks while the Mercury spacecraft was at Cape Canaveral undergoing hanger and launch pad checkouts. Each Astronaut spent hours inside the actual craft, becoming familiar with the "feel" of it.

He was inside when the spacecraft was in the pressure chamber for pressure checks. He participated in the control system checks. He practiced a complete and simulated mission. When the craft was on the launch pad, each Astronaut participated in practice countdowns, launch procedures and simulated flight tests.

In addition to all these training methods, each Astronaut had his own physical fitness program. With some it was golf, others tennis or handball. All are accomplished skin divers.

This concern with the physical and mental well-being of the Astronaut continues during the actual flight aboard the spacecraft. Three constant physical measurements were made -- body temperature, respiration and heart action. A fourth and most important check was provided by the communications system through which he was almost constantly in touch with one or more of the ground stations. Conceivably, the Astronaut's heart action, respiration and temperature could all be fairly normal -- and he would be unconscious. The voice contact was indispensable.

For the constant monitoring of body temperatures, a miniaturized thermistor-tipped device was developed for sternal application. A different thermistor attached to the microphone provided respiratory information. A modified electrocardiogram with body-attached electrodes relayed heart action. Pulse rates were plotted at approximately five-minute intervals during the early part of the countdown. As liftoff time approached, the rate was measured at 5 and 10-second intervals, continuing thus throughout the flight.

During Astronaut Alan Shepard's first space flight, his pulse rate was a fairly constant 80 beats a minute during countdown, rose to 108 prior to liftoff, was 126 at liftoff and climbed to a peak of 138 at separation of the spacecraft and booster. It was erratic during weightlessness (dropping to 108) and reached 132 just after peak re-entry acceleration.

Shepard performed well both physiologically and psychologically, according to the three methods of most accurate checking -- the on-board

camera, voice communications and the spacecraft attitude records. He monitored and reported accurately the critical events of the flight, he controlled the attitude of the spacecraft within normal limits, he was alert to unprogramed events and he showed no tendancies to distract his attention on irrelevant instrumentation or activities.

* * * * *

First U.S. Man in Orbit (Part 12)

THE DAY OF THE FLIGHT

by

Walter C. Williams

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for Operations, National Aeronautics
and Space Administration.

CAPE CANAVERAL, Florida -- After days of intense preparation, the giant Atlas launch vehicle stood on the pad ready for flight. The Mercury spacecraft rode atop its monolithic height. The gantry still enclosed it. Scores of technicians completed the final details of checking and rechecking.

The Astronaut was awakened about 2 A.M. and dressed for the first U.S. orbital flight around the earth. This was the flight for which he had spent more than two years training under the direction of the National Aeronautics and Space Administration (NASA).

Medical sensors were attached to his body to record heart beat, respiration, blood pressure, and body temperature. After donning his space suit he entered a medical van equipped with a "vibrating chair" to insure normal circulation. In the van he was also given last-minute medical checks. A little after 5 A.M. he was taken to the launch site. About 6:30 A.M. he took the gantry elevator to the third level, entered the spacecraft and with the help of the astronaut medical official and technicians, fitted himself into the Astronaut couch.

WORD ONE/KEYSEARCH

D:00-00-00 NS N:00 G:MER The Day of the Flight Williams R20012
First US Man in
Orbit Part 12

Under the Mercury spacecraft the big Atlas was poised for the journey into space. The Atlas is the oldest, most tried and tested of large American launch vehicles. The Atlas stands 82.5 feet (25 meters) high, is 10 feet (3 meters) in diameter and at launch weighs 260,000 pounds (119,000 kilograms). It is powered by two booster engines producing 150,000 pounds (68,000 kilograms) of thrust each and by one sustainer engine producing 60,000 pounds (27,200 kilograms) of thrust. It is fueled with kerosene and liquid oxygen.

In the Mercury Control Center and the launch pad blockhouse, the countdown was going on. On his couch the astronaut made his preflight checks of the instruments over which he had manual control -- communications, the escape system, temperature, horizon scanner units, retro-rockets, repressurization, flight instruments and spacecraft attitude control. He was in voice communication with two other Astronauts, one in the blockhouse and the other in the control center. They were friends with friendly voices. They knew the program equally as well as he and he would be in voice contact with them for much of his flight.

With the final checks completed, the technicians bolted down the hatch of the spacecraft, filled the cabin with oxygen and made a final inspection of the exterior.

The technicians in the blockhouse were responsible for the actual launching of Mercury-Atlas. Once the vehicle left the pad, control passed to the Mercury Control Center, a large, instrumented room at Cape Canaveral. At the front was a large parabolically curved world map marked with the plan of the orbital flight.

Below the flight map a battery of instruments and panels were manned by a score of launch technicians. There, also, was the Flight Director. Back of them and separated by a glass partition, were some 50 official observers. Directly overhead were two closed-circuit television sets focused on the launching pad. The Flight Director and his team of flight controllers had responsibility for the following:

Monitoring the flight from launch to re-entry; monitoring the Astronaut and spacecraft status; initiating an abort (escape) decision; resolving procedures which would follow an abort; monitoring re-entry; informing Astronaut on mission progress; coordinating communications facilities; and informing recovery forces.

The countdown for the first orbital flight followed normal procedures. In the final minutes the various stations in the blockhouse gave the favorable reply -- "Medical, go," "Telemetry, go," "Pressure, go," and so on. After the last second, the Atlas vehicle lifted slowly into the air, its base shrouded in flames and smoke. Rapidly accelerating under full power, it arched out over the Atlantic ocean.

Launch time in rocketry parlance is "T-time." At T plus 2 minutes the space vehicle was at an altitude of 210,000 feet (63,000 meters) and 45 miles (72 kilometers) down range. The booster engines burned out and dropped. The escape tower was jettisoned.

At T plus 5 minutes the vehicle was at orbital altitude, approximately 90 miles (144 kilometers) high, some 435 miles (696 kilometers) down range and its speed was 17,500 miles (28,160 kilometers) an hour. The

sustainer engine burned out. Using attitude jets, the Mercury spacecraft was turned into orbital position, that is, blunt nose forward as opposed to the launch position of blunt nose downward.

In orbit the Astronaut had complete control over the spacecraft. He continually corrected its attitude as necessary. He looked out the viewing port and into his periscope, reporting what he saw to the Control Center and to the tracking stations along the way -- cloud formations, storms, coastlines and continents, various celestial bodies. He checked other controls constantly. He ate and drank from squeeze tubes.

His route took him over the north Atlantic Ocean, Africa, the Indian Ocean, Australia, the Pacific and back to the western Coast of North America. At T plus 90 minutes he completed his first orbit, crossing southeast of Bermuda. At T plus 180 minutes he completed his second orbit, crossing several hundred miles farther south of Bermuda.

At T plus approximately 250 minutes the Mercury spacecraft was 370 miles (595 kilometers) West of the California coast. The astronaut prepared for his 3,000-mile (5,000-kilometer) descent course back into the atmosphere. He tilted the blunt nose of the Mercury upward about 35 degrees. He next fired the retro-rockets which slowed his speed and dropped the spacecraft out of orbit. He then changed his spacecraft attitude so that the blunt, heat-ablating nose of Mercury was pointing correctly. He was ready for re-entry and recovery.

* * * * *

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POSTLAUNCH MEMORANDUM REPORT
FOR
MERCURY-ATLAS NO. 6 (MA-6)

PART I - MISSION ANALYSIS

Classification changed to U
By authority of EO 11652, 6/1/72
Date SEC-SAV 3A+3D, SAMSO, 10/19/72
Done 4/25/74

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Cape Canaveral, Florida

March 5, 1962

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D:03-05-62 MSC N:00 R:MER Postlaunch Memorandum Report Fields R0212A
for Mercury Atlas 6 MA-6

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POSTLAUNCH MEMORANDUM REPORT

FOR

MERCURY-ATLAS NO. 6 (MA-6)

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Cape Canaveral, Florida

March 5, 1962

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NOTICE

- NO. 1: LIFT-OFF TIME (2-INCH MOTION) FOR THE MA-6 FLIGHT WAS 9:47:39.002 EST. RANGE ZERO TIME WAS ESTABLISHED AS 9:47:39 EST. ALL TIMES REFERRED TO IN THIS REPORT ARE IN ELAPSED TIME IN HRS:MIN:SEC FROM RANGE ZERO, UNLESS OTHERWISE NOTED.
- NO. 2: THE PRESENT REPORT IS PART I OF THE MA-6 POSTLAUNCH MEMORANDUM REPORT AND CONTAINS OVERALL MISSION ANALYSIS WITH A MINIMUM OF DATA. PART II, UNDER SEPARATE COVER, WILL CONTAIN COMPLETE TIME HISTORIES OF DATA, WITHOUT ANALYSIS.

1.0 INTRODUCTION

The first manned orbital spaceflight of a Mercury spacecraft was successfully made on February 20, 1962, from the Cape Canaveral Missile Test Center. Astronaut John H. Glenn Jr., shown in figures 1.0-1 through 1.0-4, was the pilot on the MA-6 mission. This flight was the third orbital flight of a Mercury spacecraft, and the sixth of the series utilizing Atlas boosters.

The flight was planned for three orbits and was a culmination of the program to develop the Mercury spacecraft and to use it for manned orbital flight. The objectives of the flight were therefore to evaluate the performance of the man-spacecraft system in a three-orbit mission, to evaluate the effects of space flight on the Astronaut, and to obtain the Astronaut's evaluation of the operational suitability of the spacecraft and supporting systems for manned space flight.

In general, the spacecraft, booster, and Network system functioned well during the mission. During the second orbit, loss of thrust of the one-pound yaw thrusters caused repeated loss of ASCS orbit mode, requiring the Astronaut to control the spacecraft for most of the mission. In spite of this and other minor problems, the three-orbit mission was completed successfully and recovery was effected in the planned area by the Destroyer "Noa" within 20 minutes after landing.

The Astronaut's performance during all phases of the mission was highly satisfactory. No deleterious effects of weightlessness were noted, and the Astronaut was found in postflight examination to be in excellent health.

All mission objectives for this flight were accomplished.



Figure 1.0-1.- John Glenn and his backup pilot Scott Carpenter.

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Figure 1.0-2.- John Glenn prior to the MA-6 mission.

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Figure 1.0-3.- John Glenn in the MA-6 spacecraft prior to hatch closure.

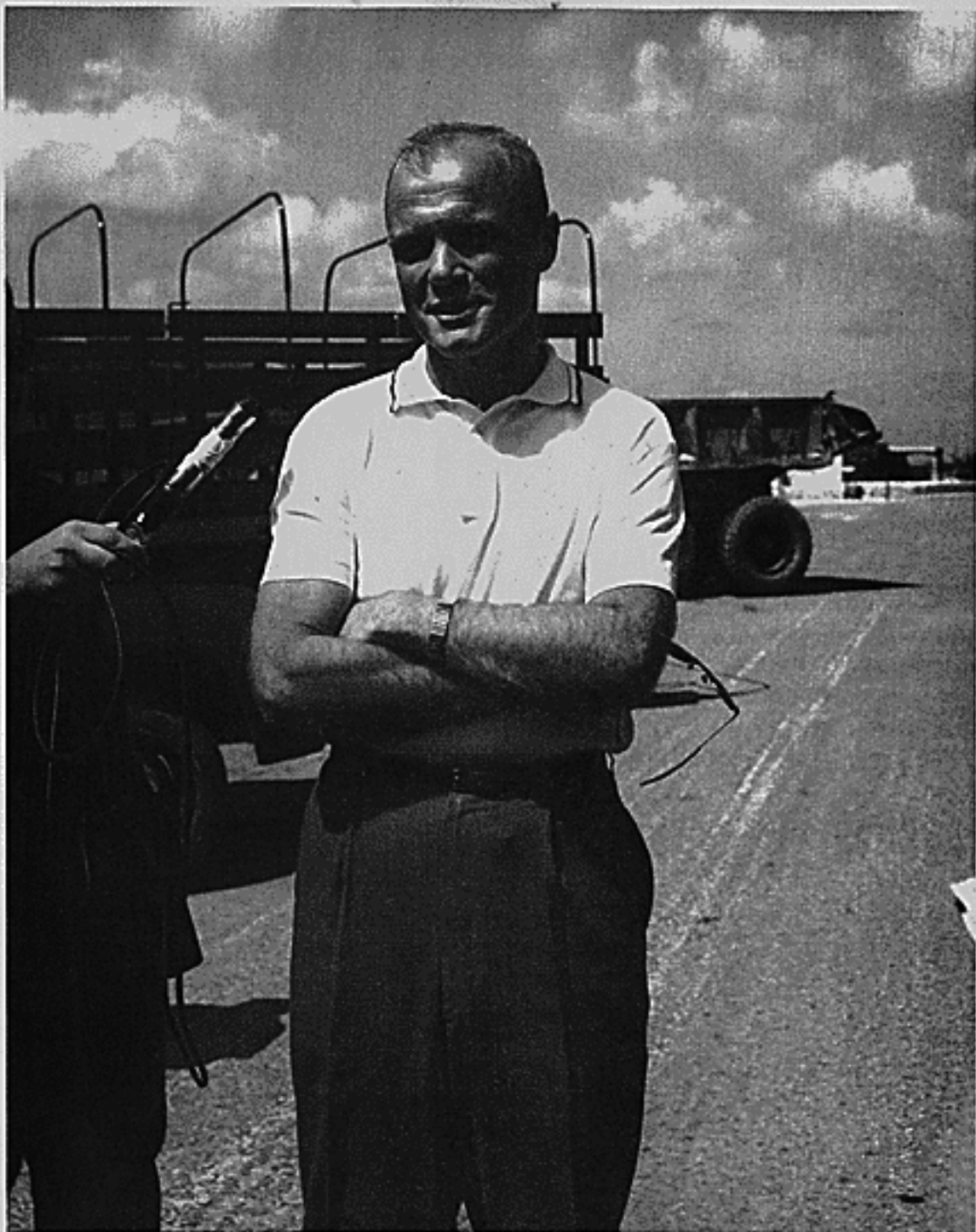


Figure 1.0-4.- Postflight photograph of astronaut John Glenn.

2.0 MISSION DESCRIPTION

The MA-6 flight was a 3-orbit mission with Astronaut John Glenn as pilot. Unscheduled prelaunch holds totaled 2 hours and 17 minutes as a result of difficulties with the GE guidance rate beacon and a spacecraft-hatch bolt, for topping fuel and loxing the launch vehicle, and to verify the Bermuda computer after a ground power failure. The vehicle lifted off at approximately 0947 e.s.t on February 20, 1962, 3 hours and 42 minutes after the astronaut entered the spacecraft.

All booster functions were normal during launch, and vibration levels and frequencies were acceptable and comparable to those experienced during the MA-5 launch. Spacecraft orbital insertion conditions were very good. Deviations from nominal values of inertial flight-path angle and velocity were $-.05$ degrees and -7 ft/sec, respectively, with a resultant capability of nearly 100 orbits. GE-Burroughs and AZUSA guidance data both indicated a "GO" condition after sustainer engine cutoff. The perigee and apogee of the orbit differed from the nominal values of 87.0 and 144.4 nautical miles by 0.1 nautical miles and 3.5 nautical miles, respectively.

Spacecraft separation, rate damping, and turnaround were accomplished satisfactorily. With the exception of steadily rising temperatures on both inverters, all spacecraft systems performed satisfactorily during the first orbit.

The pilot observed the launch vehicle tankage in its slightly lower orbit for some time, checked out the spacecraft control systems, performed planned tasks and made scientific observations, and reported small luminous-appearing particles around the spacecraft at sunrise.

At approximately the beginning of the second orbit, the astronaut reported that the spacecraft was not maintaining acceptable attitudes in the orbit mode of control in right yaw, and later in left yaw, evidently because of loss of thrust from the low thrusters. The astronaut elected to control the spacecraft manually to conserve fuel, and flew most of the rest of the mission in manual control modes. Necessary attention to control of the spacecraft prevented accomplishment of some flight-plan items.

However, the astronaut accomplished the major planned tasks, made scientific observations, confirmed that major weather phenomena were visible on the moonlit dark side of the earth, controlled the spacecraft attitudes by visual reference to horizon and stars on the dark side of the earth, and performed spacecraft maneuvers manually, including 180° yaw maneuvers. The spacecraft supported the astronaut adequately, despite the malfunction in the control system.

MISSION DESCRIPTION

Also during the second and third orbits, an indication from telemetry that the spacecraft heat shield might be unlocked caused some concern; therefore the empty retropack was retained on the spacecraft during reentry at the end of the third orbit, to hold the heat shield in place in case it was unlatched. The retropack had no detectable effect on the reentry.

The spacecraft attitudes during the retrofire maneuver were controlled by both the automatic control system and the astronaut using manual control. Spacecraft oscillations built up during reentry and were not satisfactorily controlled until the drogue parachute stabilized the spacecraft. The drogue parachute deployed at 28,000 feet rather than the planned 21,000 feet. Landing (04:55:16) occurred approximately 40 nautical miles uprange of the planned landing point. The spacecraft, with the astronaut inside, was recovered approximately 17 minutes after landing by the destroyer Noa. The astronaut was in excellent shape.

Network operations, including telemetry reception, radar tracking, communications, command control and computing were excellent, and permitted effective flight control during the mission.

The pilot observed the launch vehicle tankage in its slightly lower orbit for some time, checked out the spacecraft control systems, performed planned tasks and made scientific observations, and reported small luminous appearing particles around the spacecraft at sunrise.

At approximately the beginning of the second orbit, the astronaut reported that the spacecraft was not maintaining acceptable attitudes in the orbit mode of control in right yaw, and later in left yaw, evidently because of loss of thrust from the low thrusters. The astronaut elected to control the spacecraft manually to conserve fuel, and flew most of the rest of the mission in manual control. Necessary attention to control of the spacecraft prevented accomplishment of some flight-plan items.

However, the astronaut accomplished the major planned tasks, made scientific observations, confirmed that major weather phenomena were visible on the moonlit dark side of the earth, controlled the spacecraft attitudes by visual reference to horizon and stars on the dark side of the earth, and performed spacecraft maneuvers manually, including 180° yaw reversals. The spacecraft supported the astronaut adequately, and the astronaut supported the control system.

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3.0 LIFT-OFF CONFIGURATION DESCRIPTION

A photograph of the lift-off configuration consisting of spacecraft and launch vehicle is shown in figure 3.0-1.

3.1

Spacecraft. Spacecraft No. 13, see figure 3.1-1, was utilized for the MA-6 manned orbital mission. The spacecraft axis system is shown in figure 3.1-2. The primary differences between spacecraft No. 13 (MA-6) and spacecraft No. 9 (MA-5) are listed below:

- (a) An astronaut's couch was installed.
- (b) A personal-equipment container was installed.
- (c) Filters were provided for the astronaut's window.
- (d) An indicator was added to the instrument panel to display the temperature of the suit circuit steam vent.
- (e) The suit circuit incorporated a constant-bleed orifice (750 cc/min).
- (f) The suit shutoff valve spring force was approximately 25 lbs., compared to approximately 40 lbs. for capsule no. 9.
- (g) The cabin-fan inlet duct incorporated improved screens.
- (h) The latching relay to lock in the no. 2 suit fan was omitted.
- (i) The suit-inlet-snorkel door was located on the conical afterbody.
- (j) Cooling plates of the new design were installed under the 150 VA and 250 VA main inverters, and the stainless steel check valves were installed in the coolant line in lieu of aluminum valves.
- (k) The manual-proportional control system linkage had shear pins.
- (l) Improved heat-conduction paths, and heat sinks, were installed for temperature control of the roll thruster fuel lines near the thrusters.
- (m) Indicating lights were added to the instrument panel to show which inverters were operative.

(n) Direct (without fuses) manual switching to inverters was incorporated.

(o) The maximum altitude sensor was provided a separate battery.

(p) One-ohm fuses were installed in all squib circuits.

(q) An integrating accelerometer was installed.

(r) A Super SARAH beacon was incorporated in lieu of an Ultra SARAH.

(s) A reserve chute was installed.

(t) A switch was installed to allow manual control of heat-shield deployment.

(u) The escape tower legs were of heavier construction.

(v) A manually-actuated blood pressure measuring system was incorporated.

The measured parameters for the spacecraft are shown in the following table:

- (1) The suit inflator valve spring to the suit inflator, compared to approximately 40 lbs. for capsule no. 2.
- (2) The cabin fan inlet duct incorporated improved screens.
- (3) The switching relay to lock in the no. 2 suit fan was omitted.
- (4) The suit-inlet-locked door was located on the control airbody.
- (5) Cooling plates of the new design were installed under the 150 VA and 250 VA main inverters, and the stainless steel check valves were installed in the coolant line in lieu of aluminum valves.
- (6) The manual-proportional control system linkage had shear pins.
- (7) Improved heat-conduction paths, and heat sinks, were installed for temperature control of the roll thruster fuel lines near the thrusters.
- (8) Indicating lights were added to the instrument panel to show which inverters

Parameter	Configuration				Flotation
	Launch	Orbit	Normal Reentry Configuration	Normal Reentry Configuration Plus Retropack (Rockets Fired)	
Weight in pounds	4265.26	2986.78	2698.98	2815.95	2421.79
Center of gravity station in inches	Z 167.96	121.18	124.62	123.02	119.74
	X .31	-.04	-.07	-.06	-.33
	Y -.08	.07	.01	.01	.16
Moments of inertia, I_{xx} slugs-ft. ²	384.0	281.6	271.0	275.1	258.1
	7761.1	621.6	544.6	581.8	353.4
	7767.5	629.3	552.2	589.4	359.5

thermal characteristics. This change decreases the possibility of thermal run-away in the gyro torquer and signal amplifier.

(d) The booster tank pressure abort parameter was changed from 21.5 ± 1.0 psi to 19.5 ± 1.0 psi to protect against an inadvertent abort due to low tank-usage pressure transients which occur at lift-off.

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3.2 Vehicle.- The MA-6 booster, No. 109-D, was an Atlas Series-D modified for the mission as on previous Mercury-Atlas flights. A sketch showing the general configuration is shown in figure 3.2-1. The booster differed from the MA-5 Mercury-Atlas booster (93-D) in one major respect.

For the MA-6 booster, the insulation and its retaining bulkhead between the lox and fuel tank dome was removed when it was discovered that fuel had leaked into this insulation prior to launch. The original requirement for this insulation and retainer had been deleted earlier in the operational booster development program as being non-essential, and this insulation is not used in the operational Atlas vehicles. However, this feature was retained in the standard Series D vehicles.

The following minor modifications were incorporated and are planned for future Mercury-Atlas flights:

(a) The gyro canister was modified to include specially selected transistors of the original design type that had good thermal characteristics. This change decreases the possibility of thermal run-away in the gyro torquer and signal amplifier.

(b) The booster lox tank pressure abort parameter was changed from 21.5 ± 1.0 psi to 19.5 ± 1.0 psi to protect against an inadvertent abort due to lox - tank-ullage pressure transients which occur at lift-off.

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4.0 EVENTS, TRAJECTORY, AND GUIDANCE

- 4.1 Sequence of events.-- The times at which the major events occurred are given in table 4.1-1.
- 4.2 Trajectory.-- The ground track of the flight is shown in figure 4.2-1, and the altitude-longitude profile is shown in figure 4.2-2.

The launch trajectory data, shown in figure 4.2-3, are based on the real time output of the Range Safety Impact Predictor Computer (which used AZUSA MK II and Cape FPS-16 radars) and the GE-Burroughs guidance computer. The data from these tracking facilities were used during the time periods listed below:

Facility	Time, Min:Sec
Cape Canaveral FPS-16	0 to 00:45
AZUSA MK II	00:45 to 01:08
GE-Burroughs	01:08 to 05:02

The parameters shown for the "planned" launch trajectory were computed using the 1959 ARDC model atmosphere for consistency with other published preflight trajectory documents. The density of the Cape Canaveral atmosphere is approximately 10 percent higher than that of 1959 ARDC atmosphere in the region of maximum dynamic pressure (about 37,000 feet altitude); as a result, the maximum dynamic pressure expected would be about 10 percent higher than that shown as "planned". For this flight, the maximum dynamic pressure experienced was about 12 percent higher than that shown as "planned".

The orbital portion of the trajectory, shown in figure 4.2-4, was obtained by starting with the spacecraft position and velocity vector obtained during the second pass near Woomera (during the second orbit) as determined by the Goddard computer (using radar data from the Mercury tracking network) and integrating backward along the flight to orbital insertion and forward along the flight to the start of retrofire at the end of the third orbit. These integrated values were in excellent agreement with the GE-Burroughs guidance system measured values at orbital insertion and also in good agreement with the position and velocity vectors determined by the Goddard computer for passes near Canary Islands during the first pass (first orbit), Bermuda during the second and third pass (start of second and third orbits) and Mischea during the third pass (third orbit), thus establishing the validity of the integrated orbital portion of the flight trajectory.

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The reentry portion of the trajectory, shown in figure 4.2-5, was obtained by starting with the spacecraft position and velocity vector near Corpus Christi, Texas, as determined by the Goddard Computer and integrating backward along the flight to the end of retrofire and forward along the flight to landing assuming that the retro-package had not been jettisoned and that the drogue chute was deployed at the time of 04:49:17 (given by telemetry event indication) at an altitude of approximately 27,000 feet instead of the planned altitude of 21,000 feet. The spacecraft decelerations from the integrated reentry trajectory agree within reading accuracy with the decelerations measured by the onboard accelerometer; in addition, the times of drogue and main chute deployment from the integrated reentry trajectory and from spacecraft onboard measurements agree within one second. This agreement between the integrated values and independently measured values onboard the spacecraft serves to verify the validity of the integrated reentry portion of the trajectory. The integrated values at the end of retrofire were adjusted by adding the effects of a nominal retro-rocket total impulse of 38,880 lb-sec at nominal spacecraft retro-fire attitudes of -34° pitch with zero roll and zero yaw and the results when compared with the orbital integrated values at the start of retrofire show the velocity to be about 7 feet per second low (or that the actual retrorocket performance gave 7 feet per second more imparted velocity to the spacecraft than expected). The fact that the spacecraft landed approximately 40 nautical miles short of the nominal landing point can probably be attributed to spacecraft pitch attitude during retrofire and retrorocket performance since an error of ± 1 foot per second in retro-velocity will give an error in landing range of ± 5.2 nautical miles from the nominal landing point, and an error of $\pm 1.0^{\circ}$ in pitch attitude during retrofire will give an error in landing range of ± 10.0 nautical miles from the nominal landing point. The reentry trajectory and the landing point were only slightly affected by the retro-package being left onboard the spacecraft. The integrated landing point was about 4 nautical miles short of the spacecraft pickup point (see section 9.0).

The aerodynamic parameters for the planned and integrated reentry trajectories were computed using the MSC model atmosphere (NASA Project Mercury Working Paper No. 205), which is based on Discoverer Satellite program data above 50 nautical-mile altitude, the 1959 ARDC model atmosphere between 25 and 50 nautical-mile altitudes, and the Patrick AFB atmosphere below 25 nautical-mile altitude.

In the trajectory figures the above integrated values are labeled "actual".

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A comparison of the planned and actual trajectory parameters is given in table 4.2-1. The difference between the planned and actual trajectory parameters are due to the actual cutoff velocity and flight-path angle being slightly lower than the planned conditions.

4.3

Guidance. The GE-Burroughs Atlas guidance system performed excellently in this flight. The guidance system locked on the vehicle in both track and rate at 00:68, approximately as planned, and lost lock at 05:32 (31 seconds after SECO).

In figures 4.3-1 to 4.3-3 the velocity and flight-path angle are shown in the region of cutoff. GE-Burroughs data are shown in figure 4.3-1 and the AZUSA data used in the Range Safety Impact Predictor Computer (IP 7090) are shown in figure 4.3-2 to illustrate the noise level during the time of the GO-NO-GO computations. Both the GE-Burroughs and the AZUSA data are considered very good except for the two AZUSA points immediately after engine cutoff. The reason for these two points with such large errors is not known at this time. The points are obviously in error but are included in the figures since these points were generated by the IP 7090 computer and received by the Goddard computers as shown in the figures.

The GE-Burroughs system gave a cutoff which was about 7 ft/sec low in velocity and about 0.05° low in flight-path angle. These values are within the expected accuracy range for the system.

In figure 4.3-3 these data are shown as flight-path angle versus velocity. This is the type of display used by the Flight Dynamics Officer in the Mercury Control Center for the orbital GO-NO-GO decision. Both GE-Burroughs and AZUSA data indicated a GO decision.

0.1- (-1.0)	04:50:11	04:50:36	Main chute deploy
0.1+ (-2.0)	04:52:23	04:52:22	Main chute Jettison (water impact)

*Flight calculated, based on nominal Atlas performance.

The numbers in parentheses show the difference between the actual event and the postflight-calculated event times based on actual trajectory parameters.

* 0.05 g relay was actuated manually by astronaut when he was in a "small" field.

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TABLE 4.1-1 SEQUENCE OF EVENTS

A comparison of the planned and actual trajectory parameters is given in table 4.1-1. The difference between the planned and actual times

Event	Planned Time ^a Hr:Min:Sec	Actual Time Hr:Min:Sec	Difference Seconds
Booster-engine cutoff	00:02:11.4	00:02:09.6	-1.8
Tower release	00:02:34.2	00:02:33.3	-0.9
Escape rocket firing	00:02:34.2	00:02:33.4	-0.8
Sustainer-engine cutoff discrete (SECO)	00:05:03.8	00:05:01.4	-2.4
Tail-off complete	00:05:03.8	00:05:02	-1.8
Spacecraft separation	00:05:03.8	00:05:03.6	-0.2
Retrofire initiation	04:32:58	04:33:08	+10.0
Retro (left) no. 1	04:32:58	04:33:08	+10.0
Retro (bottom) no. 2	04:33:03	04:33:13	+10.0
Retro (right) no. 3	04:33:08	04:33:18	+10.0
Retro assembly jettison	04:33:58		
0.05 g relay	04:43:53	04:43:31*	-22.0 (0) ^b *
Drogue chute deploy	04:50:00	04:49:17.2	-82.8
Main chute deploy	04:50:36	04:50:11	-25.0 (-1.0) ^b
Main chute jettison (water impact)	04:55:22	04:55:23	+1.0 (-27.0) ^b

^a Preflight calculated, based on nominal Atlas performance.

^b The numbers in parentheses show the difference between the actual event and the postflight-calculated reentry event times based on actual insertion parameters.

* 0.05 g relay was actuated manually by astronaut when he was in a "small g field".

TABLE 4.2-1 COMPARISON OF PLANNED AND ACTUAL TRAJECTORY PARAMETERS

Condition and Quantity	Planned	Actual	Difference
<u>Cutoff conditions (including tail-off):</u>			
Range time, seconds	303.8	302.0	-1.8
min:sec	05:03.8	05:02	
Geodetic latitude, deg north	30.4273	30.4533	0.0260
Longitude, deg west	72.5268	72.5865	0.0597
Altitude, feet	528,428	528,381	-47
nautical miles	87.00	86.96	-0.04
Range, nautical miles	436.4	433.7	-2.7
Space-fixed velocity, feet per second	25715	25708	-7.0
Space-fixed flight-path angle, deg	0	-0.0468	-0.0468
Space-fixed heading angle, deg			
east of north	77.4756	77.4826	.0070
<u>Post-posigrade firing conditions:</u>			
Range time, seconds	305.8	306.8	1.0
min:sec	05:05.8	05:06	
Geodetic latitude, deg north	30.4572	30.5128	0.0556
Longitude, deg west	72.3797	72.2923	-0.0874
Altitude, feet	528460	528361	-99
nautical miles	87.0	86.96	-0.04
Range, nautical miles	444.2	449.4	5.2
Space-fixed velocity, feet per second	25737	25730	-7.0
Space-fixed flight-path angle, deg	-0.0030	-0.0517	-0.0487
Space-fixed heading angle, deg			
east of north	5541	77.6399	0.0858

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TABLE 4.2-1 Concluded

COMPARISON OF PLANNED AND ACTUAL TRAJECTORY PARAMETERS

Condition and Quantity	Planned	Actual	Difference
<u>Orbit parameters:</u>			
Perigee altitude, statute miles	100.1	100.03	-0.07
nautical miles	87.0	86.92	-0.08
Apogee altitude, statute miles	166.2	162.17	-4.03
nautical miles	144.4	140.92	-3.48
Period, min:sec	88:32	88:29	-00:03
Inclination angle, deg	32.52	32.54	0.02
<u>Maximum conditions:</u>			
Altitude, statute miles	166.2	162.17	-4.03
nautical miles	144.4	140.92	-3.48
Space-fixed velocity, feet per second	25737.0	25732.0	-5.0
Earth-fixed velocity, feet per second	24420.0	24415.0	-5.0
Exit acceleration, g's	7.7	7.7	0
Exit dynamic pressure, lbs/ft ²	966*	982	16.0
	878**		
Entry deceleration, g's	7.6	7.7	0.1
Entry dynamic pressure	447	472	25.0
<u>Landing point:</u>			
Latitude, deg:min	21°07'N	21°26'N ^a	00°19'N
Longitude, deg:min	68°00'W	68°41'W ^a	00°41'W

*Based on Cape Canaveral atmosphere.

*Based on 1959 AFDC model atmosphere.

^a"Actual" landing coordinates shown above were those resulting from the trajectory integration. The retrieval point 20 minutes after landing was reported as 21°25'N and 68°37'W by the recovery ship (see section 9.0).

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5.0 SPACECRAFT MEASUREMENTS

Overall, the spacecraft as an entity performed adequately. Some malfunctions were experienced, and are discussed in the following paragraphs. Also discussed in this section, from an overall mission viewpoint, are the spacecraft systems' general performance. Flight measurements (data) are generally not shown, except to clarify a discussion or present measurements of particular interest.

Complete time histories of spacecraft data, without analysis, are presented in the following report:

Postlaunch Memorandum Report

for

Mercury-Atlas No. 6 (MA-6)

Part II - Data

(a) and (b) used the automatic system thrusters, while (c) and (d) used the manual system thrusters. Combinations of (a) and (c), (b) and (d), or (a) and (b) may be used simultaneously. The amplifier-calibrator incorporated new single-pulse orbit logic, thus eliminating the double orbit pulses that have been experienced in the past with dirty repeater sectors. In addition, the horizon scanner reference levels were set at approximately 25% to lessen cold cloud effects, and scanner slewing was programmed for 8.5 minutes in each 30-minute period.

Flight description and analysis

Powered flight and turnaround. - Systems operation was normal in this period, although the 2 seconds of separation rate-damping was delayed 2.5 seconds by the sequence: circuitry associated with the 20% switch, thus leading to a fairly large initial roll error at the start of turnaround. Turnaround was managed adequately, although the time required (38 seconds) to settle into orbit mode was longer than normal, due to the initial roll error. Spacecraft attitudes and rates near insertion are listed in the following table:

5.1 Spacecraft control system.

General. - With the single exception of the yaw 1-pound thrusters, the spacecraft control system appears to have functioned normally throughout the entire flight. Discrepancies reported by the pilot between the attitude indicators and the ground reference are discussed below. Thruster malfunctions are discussed in detail in section 5.1.3.

5.1.1 System description. - The spacecraft had the following control systems modes:

(a) Automatic stabilization control system (ASCS), with orbit mode, orientation mode, and auxiliary damping mode.

(b) Fly-by-wire system.

(c) Manual proportional system.

(d) Rate stabilization control system (RSCS).

(a) and (b) used the automatic system thrusters, while (c) and (d) used the manual system thrusters. Combinations of (a) and (c), (b) and (c), or (b) and (d) may be used simultaneously. The amplifier-calibrator incorporated new single-pulse orbit-mode logic, thus eliminating the double orbit pulses that have been experienced in the past with dirty repeater sectors. In addition, the horizon scanner reference levels were set at approximately 25% to lessen cold cloud effects, and scanner slaving was programmed for 8.5 minutes in each 30-minute period.

5.1.2 Flight description and analysis.

Powered flight and turnaround. - Systems operation was normal in this period, although the 5 seconds of separation rate-damping was delayed 2.5 seconds by the sequence circuitry associated with the .20g switch, thus leading to a fairly large initial roll error at the start of turnaround. Turnaround was managed adequately, although the time required (38 seconds) to settle into orbit mode was longer than normal, due to the initial roll error. Spacecraft attitudes and rates near insertion are listed in the following table:

Axis	Attitude:Rate		
	Separation	Separation plus 2.5 sec (start of damping)	Separation plus 7 sec (start of turnaround)
Roll	$0^{\circ}:-1^{\circ}/\text{sec}$	$-12^{\circ}:-6^{\circ}/\text{sec}$	$-22^{\circ}:$
Pitch	$-8^{\circ}:+0.4^{\circ}/\text{sec}$	$+2^{\circ}:+5.5^{\circ}/\text{sec}$	$+4^{\circ}:$
Yaw	$180^{\circ}:-0.3^{\circ}/\text{sec}$	$170^{\circ}:-2.5^{\circ}/\text{sec}$	$160^{\circ}:$

Orbital phase. Except for the thruster malfunction discussed in section 5.2.3, the control system functioned essentially as designed. Control system exercises and usage modes are discussed in section 7.0. With the initiation of the first yaw maneuver, attitude indicators began to disagree with true spacecraft attitudes. Such disagreements are inherent in the system, and will occur whenever the yaw or roll attitudes deviate from 0° for an extended period of time, as demonstrated mathematically and with operational hardware. Numbers will be different depending upon the presence of either scanner slaving or fixed pitch orbital precession, but the effects will be similar. Each disagreement has been examined and can be explained per system design.

The following hypothetical maneuver is cited to best illustrate this point:

"Assume that the spacecraft and gyros are properly erected in the normal orbit attitude, and that the spacecraft is then yawed 90° and maintained in this yaw heading for $1/8$ orbit (11.25 min or 45° orbital travel), while the astronaut maintains a local vertical using the window reference. During this $1/8$ orbit the fixed pitch precession signal (about $4^{\circ}/\text{min}$) will drive the vertical gyro spin axis in a direction 90° from the orbital plane and at the end of this period the pitch attitude indicator will disagree with the spacecraft true attitude by 45° . At the same time the astronaut will have rolled the spacecraft 45° to maintain his vertical position with respect to the local horizon. If the spacecraft is then restored to the normal orbit attitude, the gyro spin axis will maintain its position in space, resulting in permanent attitude errors in both axes (unless corrected by slaving)."

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The 180° yaw maneuver, initiated at 3:14:00 is cited for reference as the best example of the above (see figure 5.1.2-1).

Indicated attitude errors, produced by spacecraft maneuvering, can be avoided by leaving the gyros caged during such maneuvers. New gyro references can best be restored with continuous scanner slaving if the gyros are uncaged at approximately 0° pitch, and then the capsule permitted to remain at orbit attitude (-34°) for approximately five minutes.

Three gyro cagings were executed by the astronaut during this mission phase. In each instance the spacecraft was pitched down to -15°, rather than level. In addition, during the first caging, the capsule roll attitude was at -19°.

Horizon scanner operation was as expected with short roll scanner "ignore" periods occurring just prior to sunset. All "ignores" produced by the pitch scanner can be correlated with maneuvers. Eight scanner slaving cycles occurred, as controlled by the programmer, and promptly removed all maneuver and caging errors.

Retrofire. - Retrofire occurred at 4:33:08 and was completed by 4:33:33. The astronaut provided backup to the ASCS system with manual proportional control, maintaining slightly better attitudes than were experienced on the MA-5 mission. Pitch and roll held within 1° with the yaw deviation not exceeding 2°.

.05g and reentry. - At 4:39:39 reentry pitch-up was initiated by the astronaut with the .05g relay manually actuated at 4:43:31. The .05g roll rate was initiated at 4:44:41, utilizing both manual and fly-by-wire thrusters, and reached -11°/sec within 2 seconds. By 4:46:30, pitch and yaw oscillations, with a period of 1.5 sec were in evidence with rates changing $\pm 2^\circ/\text{sec}$. The astronaut attempted to provide damping utilizing both manual and fly-by-wire thrusters. By 4:47:17 the pitch rates had increased to greater than $\pm 10^\circ/\text{sec}$ with a period of 1.1 sec while yaw rates were kept within $\pm 6^\circ/\text{sec}$ at the same frequency until 4:47:20 when they also exceeded $\pm 10^\circ/\text{sec}$. It is estimated that manual fuel depletion occurred at this time. Analysis of stick motions and rates shows that at least 50% of the thrust pulses opposed the direction of motion, 25% were approximately 90° out of phase thus decreasing, and then aiding, producing no net effect. The remaining 25% actually assisted in increasing the oscillations. Extrapolation of the rate traces provides a spacecraft swing of $\pm 5^\circ$ in the center of this time period.

At 4:47:39 the astronaut switched on the auxiliary damping system. Pitch and yaw rates decreased to within $\pm 2^\circ/\text{sec}$ in a four-second period while the roll rate decreased from $-20^\circ/\text{sec}$ to nominal $-11^\circ/\text{sec}$.

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At 4:48:32 the oscillations again began to build up in pitch and yaw.

By 4:48:40 rates were changing $\pm 10^\circ/\text{sec}$, with a period of 3.5 seconds per cycle while the roll rate showed an irregular decrease. Automatic system fuel depletion is estimated to have occurred at approximately 4:48:30. At 4:49:17 the drogue chute was deployed, with antenna fairing release and main chute deploy occurring at 4:50:11.

Behavior during the second period of oscillation compares with estimates for reentry without control. Extrapolations provide a spacecraft swing of $\pm 25^\circ$ pitch and $\pm 40^\circ$ yaw. Attitudes with respect to the vertical cannot be determined.

was 99% of the system allowable maximum; however, because of the decomposition rate linearly with time, the system was considered flight-worthy.

Flight Performance. - Prior to 01:29:24, both auto and manual subsystems functioned properly and delivered the expected thrust levels in all axes. At 01:29:24 in the first orbit, the ASCS called for 1 lb yaw-left automatic thrust chamber operation from which no rate response was received for 2 orbit-mode pulse signals. Immediately after this malfunction, the astronaut selected the manual proportional control mode and returned the spacecraft to proper yaw attitude. Repeated signals to the thrusters in both ASCS and fly-by-wire control modes substantiated that the 1 lb yaw-left chamber was not functioning properly. This condition persisted until 01:48:22 when, in the fly-by-wire mode, this thruster began to function and deliver the proper rate response. Except for a few isolated pulses of possible low thrust values, the 1 lb yaw-left operated properly for the remainder of the flight.

Within one minute and eighteen seconds of return to proper operation by the 1 lb yaw-left chamber, the 1 lb yaw-right chamber ceased to respond (01:49:40) in both ASCS and fly-by-wire control modes. The 1 lb yaw-right chamber remained inoperative for the duration of the flight except for apparent intermittent operation in the period between 04:30:00 and 04:34:00.

With the exception of the 1 lb yaw thrust chambers, all remaining chambers in both the automatic and manual subsystems functioned properly throughout the flight with no notable exceptions. At one time the astronaut voiced the opinion that a possible pitch-thrust chamber malfunction was evident but this report was not substantiated by the data. The manual-proportional control system exhibited proper operation at all times when selected with the possible exception of an instance where it appeared that the control handle may have been left with a slight deflection from neutral after a control maneuver. This condition appeared to have been corrected by the astronaut with no difficulty.

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5.1.3 Reaction Control System

Configuration.- The Reaction Control System (RCS) was of the standard configuration in both the automatic and manual subsystems. Heat sink modifications to reduce the hydrogen peroxide feed-line temperatures to the automatic and manual roll thrust assemblies were incorporated on the launch pad.

Prelaunch Activities.- Prelaunch servicing of the manual and automatic subsystems was normal with all components functioning properly during system servicing operations and thrust chamber static firings.

One abnormality was a high decomposition rate from the automatic subsystem during surveillance. The actual surveillance rate evolved was 99% of the system allowable maximum; however, because of the decomposition rate linearity with time, the system was considered flight-worthy.

Flight Performance.- Prior to 01:29:24, both auto and manual subsystems functioned properly and delivered the expected thrust levels in all axes. At 01:29:24 in the first orbit, the ASCS called for 1 lb yaw-left automatic thrust chamber operation from which no rate response was received for 5 orbit-mode pulse signals. Immediately after this malfunction, the astronaut selected the manual proportional control mode and returned the spacecraft to proper yaw attitude. Repeated signals to the thrusters in both ASCS and fly-by-wire control modes substantiated that the 1 lb yaw-left chamber was not functioning properly. This condition persisted until 01:48:22 when, in the fly-by-wire mode, this thruster began to function and deliver the proper rate response. Except for a few isolated pulses of possible low thrust values, the 1 lb yaw-left operated properly for the remainder of the flight.

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Feed Line Temperatures in Flight.- Feed line temperatures of both automatic 1 lb roll and manual roll thrust chambers were measured during flight. Manual roll feed line temperature increased approximately 300°F from prelaunch ambient conditions due to aerodynamic heating during powered flight. At completion of spacecraft turnaround, manual roll feed lines temperatures were stable at approximately 106°F.

Automatic 1 lb roll feed lines were only slightly affected by the boost phase and indicated a total temperature increase of less than 100°F from prelaunch ambient to completion of spacecraft turnaround. Maximum temperature in orbit of the manual roll feed lines was approximately 106°F. Maximum temperature in orbit of the automatic roll feed line was approximately 120°F. The effect of solar radiation on feed line temperatures was evident from data during second and third orbits. During sunlight periods of flight, slight increasing temperature trends were noted and in periods of darkness temperatures did not show an increasing trend.

Reentry heating effect on all instrumented feed lines was very pronounced with manual roll reaching a maximum of approximately 145°F and automatic roll a maximum of approximately 200°F.

Postflight Inspection.- All thrust chamber assemblies of Spacecraft 13 were disassembled on February 26, 1962, for the purpose of visual examination. Photography of noted observations was accomplished concurrently with disassembly. Loose foreign particles found upstream of the fuel-metering orifices of both 1 lb yaw thrusters were probably the cause of intermittent malfunction of the yaw thrusters. These foreign particles have been visually identified as portions of fuel distribution (Dutch weave) screens located downstream of the fuel metering orifices. The time and method by which these particles went upstream of the fuel orifice is unknown. Examination results are listed in Table 5.1.3-1, and typical photographs are shown in Figures 5.1.3-1 and 5.1.3-2.

Fuel Consumption.- The fuel consumption is shown in Table 5.1.3-2, and the reentry portion is shown in Figure 5.1.3-3.

TABLE 5.1.3-1 RESULTS OF POSTFLIGHT EXAMINATION OF THRUST CHAMBER

Thrust Chamber Assy.	Heat Barrier Screen	Orifice Condition	Dutch Weave Condition	Remarks
1 pound Yaw Right, S/N 101	Clear	5 particles on upstream face	Top screen burned and heavily eroded in center	Particle diameter approx. same as .016 orifice and length somewhat larger than .016
1 pound Yaw Left, S/N 55	Clear	Numerous dust size particles on upstream face	Top screen burned and moderately eroded	Particle size of the order 100-200 microns
1 pound Pitch Down, S/N 114	Clear	1 particle on upstream face	Small hole in top screen. Slightly burned	Particle size of the order 100-200 microns
1 pound Pitch Up, S/N 108	Clear	9 particles on upstream face	Top screen burned and practically eroded in center	Particle size same as 1 lb Yaw right, above
1 pound Roll CCW, S/N 12	Clear	Clean	Normal - only slightly discolored	
1 pound Roll CW, S/N 211	Clear	Clean	Normal - only slightly discolored	
Auto - 6 lb Roll CW, S/N 211	Clear	Clean	Normal	
Auto - 6 lb Roll CCW, S/N 12	Clear	Clean	Slight erosion	
Auto - 24 lb Pitch Up S/N 241	Clear	Clean	NA	

TABLE 5.1.3-1 (Continued)

Thrust Chamber Assy.	Heat Barrier Screen	Orifice Condition	Dutch Weave Condition	Remarks
Man. - 24 lb Pitch Up, S/N 215	Clear	Clean	NA	
Auto - 24 lb Pitch Down, S/N 12	Clear	Clean	NA	
Man. - 24 lb Pitch Down, S/N 205	Clear	Clean & wet	NA	
Auto - 24 lb Yaw left S/N 107	Clear - appears as only 1 screen	Clean	NA	
Man. - 24 lb Yaw Left, S/N 85	Clear	Clean	NA	
Auto - 24 lb Yaw Right, S/N 54	Clear	Clean	NA	
Man. - 24 lb Yaw Right, S/N 213	Clear & wet	Clean & wet	NA	
Man. - 6 lb Roll CCW, S/N 2	Clear & wet	Clean	Normal	
Man. - 6 lb Roll CW, S/N 7	Clear & wet	Clean	Normal	

TABLE 5.1.3-2

(Continued)
FUEL CONSUMPTION

Time	Maneuver or Mode	Auto System		Manual System	
		Fuel Used lbs	Fuel Remain lbs	Fuel Used lbs	Fuel Remain lbs
00:00:00	Launch AM	0	36.0	0	24.4
00:06:00	Turnaround and damping	5.8	30.2	0	24.4
01:37:00	Orbit 1 AM	4.2	26.0	0.6	23.8
03:10:00	Orbit 2	6.0	20.0	11.8	12.0
04:33:00	Orbit 3 (to retro)	8.6	11.4	5.2	6.8
04:43:27	Retro to .05g	4.0	7.4	5.6	1.2
04:49:20	.05 to drogue	7.4*	0	1.2*	0
04:50:11	Drogue to main	0	0	0	0

NOTE: Data accuracy to ± 0.5 lb fuel.

Postflight examination of onboard data revealed the automatic fuel depleted near 04:48:30 and manual at approximately 04:47:20. The manual fuel quantity indicator averaged an indicator error of approximately 8% more fuel than actual for fuel indication below 70%. The auto fuel quantity indicator averaged an indicator error of approximately 3% more fuel than actual for fuel indications throughout the scale range. Neither of the above error percentages reflects possible visual reading error of the FQI gauges.

*Fuel depletion occurred during this period.

5.2 Environmental Control System (ECS).-

5.2.2 General.- The ECS provided adequate environmental conditions for the astronaut throughout the flight. The uncomfortably warm conditions reported by the astronaut after landing are discussed in Section 7.0.

5.2.3 System Description.- The primary change in the ECS from the spacecraft no. 9 (MA-5) configuration was the addition of a constant-bleed orifice to the suit circuit. This orifice provided a continuous oxygen flow greater than the astronaut's anticipated metabolic requirement. The excess gas was exhausted into the cabin.

5.2.4 Countdown.- The temperature of the main inverters increased to higher than expected levels during the countdown. This indicated that the freon flow to the inverter cold plates, though adequate during pre-count checks, was inadequate during the final count. Temperatures of the 150-VA and 250-VA inverters at liftoff were 162°F and 120°F, respectively.

5.2.5 Launch.- The launch phase was normal. The cabin and suit pressures maintained a 5.5 psi differential above ambient during ascent and held at 5.7 and 5.8 psia, respectively.

5.2.6 Orbit.- Cabin and suit pressures maintained 5.7 and 5.8 psia, respectively, throughout the orbital flight. The decay in these pressures that had been observed in previous flights was absent for at least three possible reasons:

(a) Low cabin leakage (less than 500 cc/min.).

(b) Possible excess oxygen, supplied by the suit-circuit constant-bleed orifice, exhausted into the cabin from the suit circuit.

(c) Possible leakage from secondary oxygen supply.

The oxygen partial pressure agreed with suit pressure to within 0.5 psia and was consistently lower. Part of this difference is contributed by water vapor in the suit circuit that contributed a partial pressure of approximately 0.3 psi which, of course, is not included in the oxygen partial pressure measurement. A more careful calibration than those made for previous flights has resulted in a more satisfactory performance of this instrument.

The cabin air temperature, after the initial heating period, fluctuated about as expected as the spacecraft passed through the alternate periods of darkness and sunlight. The astronaut reported that at least five attempts to reduce cabin air temperature, by

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increasing water flow to the cabin heat exchanger, resulted in illumination of the excess water light. This indicated that the cabin heat exchanger was operating near its maximum capacity for the existing conditions. Even so, the mean cabin air temperature was steadily reduced during the mission after the first hour in orbit.

The suit inlet temperature (figure 5.2.6-1) varied between 65° and 75°F during the orbit phase. The astronaut reported a coolant flow of 1.7 lbs./hr. to the suit heat exchanger, and a stream exhaust temperature of 65°F. These values are both higher than anticipated and contradict each other since freezing of the exchanger would be expected at this flow rate. No explanation of this anomaly can be offered at this time.

The 150- and 250-VA inverter temperatures (figure 5.2.6-1) increased steadily from launch values of 162° and 120°F, to 204° and 197°F, respectively, at landing. Postflight testing revealed that the check valve between the coolant supply and the cold plates was stuck in the closed position and would not permit coolant to flow to the cold plates in orbit. The coolant tank was charged with 25 pounds of water before the flight. The coolant quantity indicating system showed a usage of 7.2 pounds. Postflight weighing indicated a usage of 11.8 pounds. The difference in calibration and final system temperatures can account for about 3.8 pounds of the 4.6 pounds discrepancy; the remaining 0.8 pounds is considered to be instrument error.

5.2.7 Reentry and Postlanding.- The maximum cabin temperature during this period was 103°F, which is satisfactory. The suit inlet temperature increased to 86°F during the postlanding phase. This value is reasonable since the air temperature in the landing area was 76° and the suit compressor raises the temperature in the suit circuit by approximately 10°F.

5.2.8 Anomalies.- Examination of the flight data and postflight checks of the environmental control system have revealed several anomalies. As shown in Fig. 5.2.8-1, the secondary oxygen supply exhibited an unexpected decay in pressure, first noted after approximately 01:50:00; however, it is not known when this decay began since the secondary oxygen bottle was serviced to about 8000 psig before flight and the pressure transducer had a maximum indicating value of only 7500 psig. Postflight tests indicated that the secondary system was free of leaks. Also, the postflight checks indicated a usage rate of only 0.13 pounds per hour through the suit circuit compared with about 0.18 pounds per hour obtained during prelaunch tests. Finally, the pressure decay rate of the primary supply decreased to much lower than expected values during the last of the mission, and during the last three quarters of an hour in orbit the decay rate of the secondary supply was essentially zero. No explanation for these anomalies can be offered at this time.

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5.4 Spacecraft Mechanical, Rocket, and Pyrotechnic Systems.- All systems apparently functioned normally, with the exception of early drogue chute deployment and indication of heat shield deployment during orbital flight. These anomalies, along with general systems performance, are discussed in the following paragraphs.

Parachutes.- The performances of the drogue and main parachutes upon deployment were satisfactory. Since neither parachute was recovered, a detailed post-launch visual inspection could not be made. However, observation by the astronaut verified that both parachutes were deployed cleanly and were undamaged during descent. The main chute deployed at a pressure altitude of 10,000 feet, as determined from pressures measured onboard. This is within the specification limits of $10,600 \pm 750$ feet.

The drogue parachute deployed at a higher-than-normal altitude, probably above 27,000 feet pressure altitude. Onboard pressure measurements (commutated) indicate a pressure altitude of approximately 29,000 feet at the time of drogue chute deployment, and the integrated trajectory is consistent with a drogue deployment at about 27,000 feet. The astronaut reported an altitude of 30,000-35,000 feet indicated at the time of drogue deployment. The astronaut stated that he had raised his arm to manually initiate drogue deployment when deployment occurred automatically. The drogue chute barostats actuated properly within specification pressure altitudes of $21,000 \pm 1500$ feet in postflight tests. The reason for the higher-than-normal altitude at drogue deployment is not known at this time; the investigation is continuing.

Rockets and Pyrotechnics.- A post-flight examination of the spacecraft and analysis of data indicates that all rockets and pyrotechnics functioned as intended. It cannot be determined whether certain pyrotechnics actually fired (such as redundant clamp-ring bolts and tower jettison rocket ignition) since the available evidence shows only that the resulting function was satisfactory.

Explosive-Actuated Hatch.- After the spacecraft was secured onboard the recovery ship, the astronaut initiated the hatch explosive-mechanism thru the use of the interior actuator push-button on the hatch. From visual inspection the hatch appeared to fire satisfactorily.

Landing Bag.- The landing-attenuation system apparently performed normally, as evidenced by the astronaut's statements and from postflight examinations. The landing bag was found to be torn in several places, from unknown causes, but no restraining cables or straps were broken. The usual minor damage to ablation shield retaining studs and to the bulkhead-protective shield was experienced. The main pressure bulkhead was undamaged except for a small dent near the center.

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Heat Shield-Deploy Mechanism. - Post-launch tests of the heat shield-deploy limit switches revealed a switch which would allow a "deployed" signal without a rotational (unlocking) movement of the heat shield unlatching mechanism. In addition, the pilot reported noises and other indications of heat shield deployment when he manually initiated the heat shield deployment at 2 1/2 minutes after main chute deployment, thus leading to the conclusion that the shield mechanism was not unlatched in orbit.

Deployment were satisfactory. A detailed post-launch visual inspection could not be made. However, observation by the astronaut verified that both parachutes were deployed cleanly and were undamaged during descent. The main chute deployed at a pressure altitude of 10,000 feet, as determined from pressures measured onboard. This is within the specification limits of 10,000 ± 150 feet.

The drogue parachute deployed at a higher-than-normal altitude, probably above 27,000 feet pressure altitude. Onboard pressure measurements (commenced) indicate a pressure altitude of approximately 29,000 feet at the time of drogue chute deployment, and the integrated trajectory is consistent with a drogue deployment at about 27,000 feet. The astronaut reported an altitude of 30,000-32,000 feet indicated at the time of drogue deployment. The astronaut stated that he had raised his arm to manually initiate drogue deployment when deployment occurred automatically. The drogue chute parachute actuated properly within specification pressure altitudes of 21,000 ± 1500 feet in postflight tests. The reason for the higher-than-normal altitude at drogue deployment is not known at this time; the investigation is continuing.

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5.5 Electrical and Sequential.

5.5.1 Electrical System. - The spacecraft electrical system was a specification spacecraft configuration.

One-ohm fuse resistors were installed in all squib firing circuits. Inverter monitor lights were installed to tell the Astronaut when the 150 VA and 250 VA inverters were operating.

Main bus voltage and D.C. current were as expected throughout the mission. Fans and ASCS A.C. bus voltages were also normal.

The inverter temperatures were about 162°F on the 150 VA inverter and 120°F on the 250 VA inverter at lift-off and increased gradually throughout the mission to 212° and 203°, respectively. This indicated that the inverters received little or no inflight cooling. Inverter cooling is discussed in section 5.3.

5.5.2 Sequential System. - The sequential system performed as was expected during the flight with the following exceptions:

(a) Spacecraft separation T/M segment 47, cap sep telelight, periscope extend, and damping command to the ASCS were received three seconds after spacecraft separation indication from booster telemetry. The time discrepancy is attributed to MA-6 not having electrically latched capsule adapter bolt fire relays to keep the capsule separation circuitry armed during posigrade firing. Earlier capsules had this latching feature as will subsequent capsules.

(b) Heat-shield-deployed indication (segment 51) on telemetry came on prematurely and cycled ON-OFF several times during flight. This was caused by a defective limit switch (left-hand switch). Further investigations are planned to determine exact defect of the switch. The landing bag was deployed manually by the Astronaut at about 2½ minutes after main chute deploy and functioned properly.

(c) Re-entry was performed with the retro-pack attached. This prevented the .05g event from occurring automatically, and was initiated manually by the Astronaut. Retro-package separation indications did not occur since the electrical signal to fire the retro-pack separation bolt was never given. This caused the cameras to remain on high speed from retro attitude command until power was removed after impact.

(d) The drogue chute was deployed prematurely at about 28,000 feet. The reason for this is unknown at the present time. The 21,000 foot barostats were removed after flight and subjected to a pre-installation acceptance test and functioned properly. Further tests of the static system were performed and are discussed in the Mechanical Systems section of this report.

5.6

Vibration. - Vibrations measured during the powered phase of the MA-6 mission were almost identical with those measured during the MA-5 mission. These vibrations can be seen as oscillations on the spacecraft pitch rate gyro output, as shown in figure 5.6-1. The information available indicates that the pilot's performance was not impaired by these vibrations.

One-ohm three resistors were installed in the inverter monitor lights were installed to tell the Astronaut when the 150 VA and 250 VA inverters were operating. Main bus voltage and D.C. current were as expected throughout the mission. Fans and ASCS A.C. bus voltages were also normal. The inverter temperatures were about 165°F on the 150 VA inverter and 180°F on the 250 VA inverter at lift-off and increased gradually throughout the mission to 215° and 203°, respectively. This indicated that the inverters received little or no in-flight cooling. Inverter cooling is discussed in section 5.3.

Sequential System. - The sequential system performed as was expected during the flight with the following exceptions:

(a) Spacecraft separation T/M segment 14, cap sep telelight, periscope extend, and damping command to the ASCS were received three seconds after spacecraft separation indication from booster telemetry. The time discrepancy is attributed to MA-6 not having electrically latched capsule adapter bolt fire relays to keep the capsule separation circuitry armed during postgrade firing. Earlier capsules had this latching feature as well as subsequent capsules.

(b) Heat-shield-deployed indication (segment 21) on telemetry came on prematurely and cycled ON-OFF several times during flight. This was caused by a defective limit switch (left-hand switch). Further investigations are planned to determine exact defect on the switch. The landing bag was deployed manually by the Astronaut at about 2½ minutes after main chute deploy and functioned properly.

(c) Re-entry was performed with the retropack attached. This prevented the 0.5g event from occurring automatically, and was initiated manually by the Astronaut. Retro-package separation indications did not occur since the electrical signal to fire the retropack separation bolt was never given. This caused the cameras to remain on high speed from retro attitude command until power was removed after impact.

(d) The drogue chute was deployed prematurely at about 28,000 feet. The reason for this is unknown at the present time. The 21,000 foot periscope was removed after flight and subjected to a pre-installation acceptance test and functioned properly. Further tests of the static system are planned and are discussed in the Mechanical Systems section of the report.

6.0 LAUNCH VEHICLE (BOOSTER) PERFORMANCE

General.- All booster systems performed satisfactorily. The following items are noted for information.

- 6.1 Abort Sensing and Implementation System (ASIS).- The ASIS performed satisfactorily. None of the abort parameters was near its abort threshold. As expected in normal sequence, an ASIS abort signal was generated following SECO (sustainer engine cutoff).
- 6.2 Cutoff.- SECO and ASCO (auxilliary sustainer cutoff) were transmitted and at least one was received and properly acted upon by the booster. Instrumentation does not permit determination of whether or not both signals were acted upon by the booster.
- 6.3 Booster lifetime in orbit.- Computed data based upon probable thrust having been imparted to the booster tankage by the spacecraft posigrade rockets (-4 feet per second) indicates at least 10 orbits to be expected from the booster. Tracking during the third orbit indicated a perigee of 95.75 nautical miles and an apogee of 131.0 nautical miles, and a period of 87.38 minutes. No useful tracking data were obtained after the fourth orbit.
- 6.4 Aerodynamic loads.- The angle of attack times dynamic pressure (αq) for the flight is shown in figure 6.3-1.

7.0 PILOT ACTIVITIES, AND MEDICAL REPORT

This section reports in three parts the reactions of the pilot during this first orbital flight. Leading off is a slightly edited narrative account of the mission by the pilot obtained within two hours after landing. The pilot discusses with clarity and good understanding the major events of the flight and expresses his satisfaction with his ability to control the spacecraft. This section is followed by a medical report covering the detailed pre- and postflight medical examinations and the evaluation of inflight physiological data. These medical findings indicate that the pilot's reactions both during and after the flight were normal. This section is concluded with a report on the many, diverse activities of the pilot during the flight in controlling the vehicle and making scientific observations.

Starting back with highlights of the flight: Insertion was normal this morning except for the delays that were occasioned by hatch-pot trouble and by the microphone lifting breaking off in my helmet. The weather cleared up nicely and after only moderate delays, we got off.

Lift-off was just about as I had expected. There was some vibration. Coming up off the pad, the roll programing was very noticeable as the spacecraft swung around to the proper azimuth. There also was no doubt about when the pitch programing started. There was some vibration at lift-off from the pad. It smoothed out just moderately; never did get to very smooth flight until we were through the high p area. At this time I would guess a minute and fifteen to twenty seconds - it was very noticeable. After this, it really smoothed out and by a minute and a half, or about the time cabin pressure sealed off, it was smooth as could be.

The staging was normal, though I had expected a more sharp cutoff. It felt as though the g ramped down for maybe half a second. For some reason, it was not as abrupt as I had anticipated it might be. The accelerometers read one and a quarter g's when I received a confirmation on staging from the Capsule Communicator. I had been waiting for this message at that point because I was set to go to tower jettison as we had planned, in case the booster had not staged. At this time, I also saw a wisp of smoke and I thought perhaps the tower had jettisoned early.

* Astronaut's spontaneous report recorded onboard the Descent Module shortly after the MA-6 mission on February 20, 1968. Slightly edited only.

7.1

Brief Summary of MA-6 Orbital Flight* by Astronaut Glenn. - There are many things that are so impressive, it's almost impossible to try and describe the sensations that I had during the flight. I think the thing that stands out more particularly than anything else right at the moment is the reentry during the fireball. I left the shutters open specifically so I could watch it. It got a brilliant orange color; it was never too blinding. The retro pack was still aboard and shortly after reentry began, it started to break up in big chunks. One of the straps came off and came around across the window. There were large flaming pieces of the retro pack - I assume that's what they were - that broke off and came tumbling around the sides of the capsule. I could see them going on back behind me then and making little smoke trails. I could also see a long trail of what probably was ablation material ending in a small bright spot similar to that in the pictures out of the window taken during the MA-5 flight. I saw the same spot back there and I could see it move back and forth as the capsule oscillated slightly. Yes, I think the reentry was probably the most impressive part of the flight.

Starting back with highlights of the flight: Insertion was normal this morning except for the delays that were occasioned by hatch-bolt trouble and by the microphone fitting breaking off in my helmet. The weather cleared up nicely and after only moderate delays, we got off.

Lift-off was just about as I had expected. There was some vibration. Coming up off the pad, the roll programing was very noticeable as the spacecraft swung around to the proper azimuth. There also was no doubt about when the pitch programing started. There was some vibration at lift-off from the pad. It smoothed out just moderately; never did get to very smooth flight until we were through the high q area. At this time - I would guess a minute and fifteen to twenty seconds - it was very noticeable. After this, it really smoothed out and by a minute and a half, or about the time cabin pressure sealed off, it was smooth as could be.

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* Astronaut's spontaneous report recorded onboard the Destroyer Noa shortly after the MA-6 mission on February 20, 1962. Superficial editing only.

The tower really had not jettisoned at that time and did jettison on schedule at 2+34. As the booster and capsule pitched over and the tower jettisoned, I had a first glimpse of the horizon; it was a beautiful sight, looking eastward across the Atlantic.

Toward the last part of the insertion, the vibration began building up again. This I hadn't quite expected; it wasn't too rough but it was noticeable. Cutoff was very good; the capsule acted just as it was supposed to. The ASCS damped and turned the spacecraft around. As we were completing the turnaround, I glanced out of the window and the booster was right there in front of me. It looked as though it wasn't more than a hundred yards away. The small end of the booster was pointing toward the northeast and I saw it a number of times from then on for about the next seven or eight minutes as it slowly went below my altitude and moved farther away. That was very impressive.

I think I was really surprised at the ease with which the controls check went. It was almost just like making the controls check on the Procedures Trainer that we've done so many times. The control check went off like clockwork; there was no problem at all. Everything damped when it should damp and control was easy. Zero-g was noticeable at SECO. I had a very slight sensation of tumbling forward head-over-heels. It was very slight; not as pronounced an effect as we experience on the centrifuge. During turnaround, I had no sensation of angular acceleration. I acclimated to weightlessness in just a matter of seconds; it was very surprising. I was reaching for switches and doing things and having no problem. I didn't at any time notice and tendency to overshoot a switch. It seemed it's just natural to acclimate to this new condition. It was very comfortable. Under the weightless condition, the head seemed to be a little farther out of the couch which made it a little easier to see the window, though I could not get up quite as near to the window as I thought I might.

The rest of the first orbit went pretty much as planned, with reports to the stations coming up on schedule. I was a little behind at a couple of points but most of the things were going right according to schedule, including remaining on the automatic control system for optimum radar and communications tracking. Sunset from this altitude is tremendous. I had never seen anything like this and it was a truly beautiful, beautiful sight. The speed at which the sun goes down is very remarkable, of course. The brilliant orange and blue layers spread out probably 45° to 60° each side of the sun tapering very slowly toward the horizon. I could not pick up any appreciable Zodiacal light. I looked for it closely; I think perhaps I was not enough night adapted to see it. Sunrise, I picked up in the periscope. At every sunrise, I saw little specks, brilliant specks, floating around outside the capsule. I have no idea what they were. On

the third orbit, I turned around at sunrise so that I could face into the sun and see if they were still heading in the same direction and they were. But I noticed them every sunrise and tried to get pictures of them.

Just as I came over Mexico at the end of the first orbit, I had my first indication of the ASCS problem that was to stick with me for the rest of the flight. It started out with the yaw rate going off at about one and one-half degrees per second to the right. The capsule would not stay in orbit mode, but would go out of limits. When it reached about 20° instead of the 30° I expected, it would kick back into orientation mode and swing back with the rate going over into the left yaw to correct back to its normal orbit attitude. Sometimes, it would cross-couple into pitch and roll and we'd go through a general disruption or orbit mode until it settled down into orbit attitude. The yaw would again start a slow drift to the right and the ASCS would kick out again into orientation mode. I took over manually at that point and from then on, through the rest of the flight, this was my main concern. I tried to pick up the flight plan again at a few points and I accomplished a few more things on it, but I'm afraid most of the flight time beyond that point was taken up with checking the various modes of the ASCS. I did have full control in fly-by-wire and later on during the flight, the yaw problem switched from left to right. It acted exactly the same, except it would drift off to the left instead of the right. It appeared also that any time I was on manual control and would be drifting away from regular orbit attitude for any appreciable period of time that the attitude indications would then be off when I came back to orbit attitude. I called out some of these and I remember that at one time, roll was off 30°, yaw was off 35°, and pitch was off 76°. These were considerable errors and I have no explanation for them at this time.* I could control on fly-by-wire and manual very adequately. It was not difficult at all. Fly-by-wire was by far the most accurate means of control, even though I didn't have accurate control in yaw at all times.

Retro-rockets were fired right on schedule just off California and it was surprising coming out of the zero-g field that the retro-rockets firing felt as though I were accelerating in the other direction back toward Hawaii. However, after retrofire was completed when I could glance out of the window again, it was easy to tell, of course, which way I was going, even though my sensations during retrofire had been that I was going in the other direction. I made retrofire on automatic control. Apparently, the solid-on period for slaving just prior to retrofire brought the gyros back up to orbit attitude, because they corrected very nicely during that period. The spacecraft was just about in orbit attitude as I could see it from the window and through the periscope just prior to retrofire. So, I feel that we were right

* For explanation of these differences, see Section 5.1.

I left it on ASCS and backed up manually and worked right along with the ASCS during retrofire. I think the retroattitude held almost exactly on and I would guess that we were never more than 30 off in any axis at any time during retrofire.

Following retrofire, a decision was made to have me reenter with the retropackage still on because of the uncertainty as to whether the landing bag had been extended. I don't know all the reasons yet for that particular decision, but I assume that it had been pretty well thought out and it obviously was.* I punched up .05g manually at a little after the time it was given to me. I was actually in a small g-field at the time I pushed up .05g and it went green and I began to get noise, or what sounded like small things brushing against the capsule. I began to get this very shortly after .05g and this noise kept increasing. Well before we got into the real heavy fireball

area, one strap swung around and hung down over the window. There was some smoke. I don't know whether the bolt fired at the center of

the pack or what happened. The capsule kept on its course. I didn't get too far off of reentry attitude. I went to manual control for

reentry after the retros fired and had no trouble controlling reentry attitude through the high-g area. Communications blackout started a

little bit before the fireball. The fireball was very intense. I left the shutters open the whole time and observed it and it got to be a

very, very bright orange color. There were large flaming pieces of what I assume was the retropackage breaking off and going back behind

the capsule. This was of some concern, because I wasn't sure of what it was. I had visions of them possibly being chunks of heat shield

breaking off, but it turned out it was not that. The oscillations that built up after peak-g were more than I could

control with the manual system. I was damping okay and it just plain overpowered me and I could not do anymore about it. I switched to

Aux. Damp as soon as I could raise my arm up after the g-pulse to help damp and this did help some. However, even on Aux. Damp, the cap-

sule was swinging back and forth very rapidly and the oscillations were divergent as we descended to about 35,000 feet.** At this point, I

selected to try to put the drogue out manually, even though it was high, because I was afraid we were going to get over to such an attitude that

the capsule might actually be going small end down during part of the flight if the oscillations kept going the way they were. And just as

I was reaching up to pull out the drogue on manual, it came out by itself. The drogue did straighten the capsule out in good shape. I

believe the altitude was somewhere between 30,000 and 35,000 at that point.

I came on down; the snorkels, I believe, came out at about 16,000 or 17,000. The periscope came out. There was so much smoke and dirt on

* For further discussion, see Section 8.2.

** Reentry oscillations are discussed in Sections 5.1 and 7.3.

the windshield that it was somewhat difficult to see. Every time I came around to the sun - for I had established my roll rate on manual - it was virtually impossible to see anything out through the window.

The capsule was very stable when the antenna section jettisoned. I could see the whole recovery system just lined up in one big line as it came out. It unreeled and blossomed normally; all the panels and visors looked good. I was going through my landing checkoff list when the Capsule Communicator called to remind me to deploy the landing bag. I flipped the switch to auto immediately and the green light came on and I felt the bag release. I was able to watch the water coming towards me in the periscope. I was able to estimate very closely when I would hit the water. The impact bag was a heavier shock than I had expected, but it did not bother me.

Communications with the recovery ship Noa were very good. The Noa had me in sight before impact and estimated 20 minutes to recovery which turned out to be about right. When the destroyer came alongside, they hooked on with the shepherd's hook and cut the HF antenna. During capsule pickup, I received one good solid bump on the side of the ship as it rolled. Once on deck I took the left hand panel loose and started to disconnect the suit hose in order to hook up the hose extension prior to egressing through the upper hatch. By this time I was really hot - pouring sweat. The capsule was very hot after reentry and I really noticed the increase in humidity after the snorkels opened. I decided that the best thing at that point was to come out the side rather than through the top. I am sure I could have come out the top if I had had to, but I did not see any reason to keep working to come out the top.

So I called the ship and asked them to clear the area outside the hatch. When I received word that the area was clear, I removed the capsule pin and hit the plunger with the back of my hand. It sprung back and cut my knuckles slightly through the glove. The noise of the hatch report was good and loud but not uncomfortable.

In summary, my condition is excellent. I am in good shape; no problems at all. The ASCS problems were the biggest I encountered on the flight. Weightlessness was no problem. I think the fact that I could take over and show that a pilot can control the capsule manually, using the different control modes, satisfied me most. The greatest dissatisfaction I think I feel was the fact that I did not get to accomplish all the other things that I wanted to do. The ASCS problem overrode everything else.

I came on down; the snorkels, I believe, came out at about 15,000 or 17,000. The periscope came out. There was no much smoke and dirt on

7.2

Aeromedical investigations.-

7.2.1

Introduction.- The aeromedical investigations conducted with the MA-6 mission can be logically grouped into two distinct areas: (1) the preflight and postflight clinical examinations (static examinations) and (2) the preflight and inflight physiological studies (dynamic studies). These investigations are designed to ascertain the state of the astronaut's health and to provide information reflecting human responses to space flight. The MA-6 mission provided a period of weightlessness of sufficient duration so that the pilot's physiological responses attained a relatively steady state. In the much shorter Mercury-Redstone Flights, little time was available in weightlessness for the astronaut's physiological adjustment mechanisms to stabilize.

The astronaut's activities during the time immediately prior to his countdown and flight have some indeterminate but probably significant effect on his countdown and flight responses. For this reason his activities for the approximate 9 hour period prior to his arrival at the spacecraft are listed in Table 7.2.1-1.

7.2.2

Clinical studies.- Detailed medical examinations were performed prior to space flight and as soon after flight as recovery practices permitted. Initial examinations were accomplished to determine the astronaut's state of health and his medical fitness for flight. In addition, such clinical evaluations serve as baseline medical data which may be correlated with inflight physiological information.

7.2.2.1

Data sources.-

(a) Yearly physical examinations beginning with astronaut selection in 1959.

(b) Detailed preflight clinical examinations conducted on January 22, 1962, and February 12, 1962.

(c) Preflight examination conducted on launch morning.

(d) Postflight medical evaluations on the recovery ships and at Grand Turk Island Medical Facility.

The numerous preflight examinations on Astronaut Glenn disclosed no significant medical abnormalities; his physical and mental health remained excellent throughout.

7.2.2.2

Postflight.- Emergence from the spacecraft onboard the Destroyer Noa occurred 39 minutes after landing. The pilot was described as appearing hot, sweating profusely and fatigued. He was lucid, although not talkative.

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After removal of his pressure suit, and a shower, he became more communicative and described a mild sensation of "stomach uneasiness" or "stomach awareness" which occurred while the spacecraft was on the water 17 minutes awaiting recovery. This sensation did not commence until after spacecraft landing, and cleared spontaneously within 1½ hours. No nausea or vomiting was experienced.

This stomach uneasiness could be attributed to several factors. One factor could be the combination of temperature and humidity after landing. At landing, the ambient air temperature was 75°F with 60-65 percent relative humidity and the water temperature was 81°F. The suit inlet temperature was 83°F and the cabin air temperature was 101°F. A second factor could be the moderate dehydration of the astronaut as evidenced by weight loss (5-5/16 pounds vs. a 2-1/2 pound loss during a three orbit centrifuge simulation), diminished urine output with increased specific gravity for the 24 hours post-recovery, increased blood concentration, and the recovery physician's clinical impression.

The astronaut had a minimal fluid intake, having ingested the equivalent of 94 cc of water (as applesauce puree) during the 13 hours from breakfast at 0250 to shipboard at 1545 e.s.t. His urine output during this period was 800 cc. He reported voiding this specimen just prior to reentry. The fluid intake and output is shown in the following table:

FLUID INTAKE AND OUTPUT (all times e.s.t.)

Urine output*:	countdown	0 cc
	inflight	800 cc, Sp. Gr. 1.016
	postflight, shipboard	0 cc
	Total	800 cc
Fluid intake:	countdown	0 cc
	inflight**	94 cc
	postflight, shipboard	1545 hours 265 cc iced tea
		1830 hours 240 cc water
		1850 hours 125 cc coffee
	Total	724 cc

* See also Table 7.2.2.2-1

** 119.5 grams of applesauce puree (78% water).

The only other intake during the flight was one 5.0 gram sugar tablet (xylose) for a test of intestinal absorption.

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The postflight positive physical findings and vital signs are compared with preflight values in the following table:

Variables	Preflight	Postflight
General status	Eager for flight	Alert, but not talkative; sweating profusely; appeared fatigued; not hungry.
Weight	171 7/16 pounds at 0315 hours	166 2/16 pounds at 1850 hours
Temperature	98.2°F (oral)	99.2°F (rectal at 1600 hours) 98°F (oral at 2400 hours)
Respiration	14	14
Pulse	68	72
Blood pressure	118/80 (left arm, sitting)	120/60 (left arm, supine) at 1545 hours 128/68 (left arm, sitting) at 2130 hours

Heart and lungs	Normal	Normal - no change
Skin	No erythema or abrasions	Erythema of biosensor sites. Superficial abrasions second and third fingers of right hand.
Extremities	Normal	Normal
Measurements	left right left right	left right left right

Wrist	6 7/8"	7"	6 3/4"	7"
Calf (max)	16 7/8"	16 1/2"	16 5/8"	16 1/8"
Ankle (min)	9 3/8"	9 1/8"	9"	9 1/4"

All times e.s.t. Data reflecting physiological responses were obtained by evaluating the biosensor real time recordings from range stations and from the continuous onboard recording. In addition, various inflight tests and the pilot-observer-camera film were utilized for further objective analysis. Subjective evaluation included pilot reports from onboard voice and the total postflight debriefing. The countdown

The postflight physical examination onboard the destroyer recorded the vital signs noted above. There were two small, superficial skin abrasions of the knuckles of the second and third fingers of the right hand but without deformation or fracture. These were received when the explosive hatch actuator recoiled against the pilot's gloved hand. The skin also revealed an area of moderate erythema (reddening) and a skin depression under the left arm blood pressure microphone; furthermore, there was a mild reaction to the moleskin adhesive plaster which attached the four ECG electrodes. Results of the eye, ear, nose and throat examinations were normal. The heart rhythm, size and sounds were normal and the lungs were clear, without physical evidence of atelectasis (lung collapse). Results of the examination of the abdomen were normal, and the lower extremities showed no evidence of edema (swelling) nor thrombosis (clotting). The results of the general neurologic examination were also normal.

Blood and urine samples were obtained and processed for later analysis. Results available to date are listed in Table 7.2.2.2-1.

Approximately three hours after landing, the astronaut was transferred to the Aircraft Carrier U.S.S. Randolph where a posterior-anterior and lateral chest X-ray, standard 12-lead electrocardiogram, and body weight were obtained.

Later the astronaut flew to Grand Turk Island where a general physical examination was begun at 2130 hours e.s.t., approximately 6-3/4 hours after spacecraft landing. The vital signs at that time are included with the postflight values above. Except for the previously described superficial skin abrasions, the results of the entire examination were normal. During the subsequent 48 hours, comprehensive examinations by medical specialists were conducted. Special tests were performed in an effort to delineate any effect of space flight upon the astronaut's balance (inner ear); no effect was detected. Both the general and the specialists' examinations revealed no significant changes. The medical studies were completed at 1400 e.s.t., February 22, 1962.

In summary, the preflight and postflight clinical studies revealed no significant differences and, except for the immediate postflight moderate dehydration, were completely within normal limits.

7.2.3 Physiological studies.

- 7.2.3.1 Data sources. - Data reflecting physiological responses to flight were obtained by evaluating the biosensor real time recordings from range stations and from the continuous onboard recording. In addition, various inflight tests and the pilot-observer-camera film were utilized for further objective analysis. Subjective evaluation included pilot reports from onboard voice and the total postflight debriefing. The countdown

period provided baseline preflight information. Useful comparative measurements were available from the Mercury-Atlas Centrifuge Three Orbital Simulation; and from the pad simulated launch, simulated flights, and the January 27 launch attempt. Environmental control system data were correlated with physiological responses where appropriate.

7.2.3.2 Bioinstrumentation. - In addition to that used in the manned Mercury-Redstone flights (two ECG leads, respiratory rate sensor, and body temperature sensor), a blood pressure device was utilized in flight. The blood pressure apparatus consisted of a pneumatic nylon cuff, placed on the left upper arm, and a microphone located under the cuff over the brachial artery. To obtain the blood pressure the cuff was inflated manually. The record consisted of the sound pulses superimposed on a cuff pressure decay curve. This record was displayed on the second ECG channel.

The total biosensor monitoring time, from astronaut insertion until just prior to landing, was eight hours and fifteen minutes. The biosensor readout quality was excellent throughout the countdown and flight with the exception of the respiratory trace. As in prior flights, variation with head position and air density combined to reduce the quality of the respiration trace. There were brief periods of noise on the ECG channels during countdown and flight usually occurring during vigorous pilot activity.

7.2.3.3 Preflight. - Figure 7.2.3.3-1 depicts the pulse rate, respiration rate, body temperature, and blood pressure values recorded during the MA-6 countdown. Values for the same physiological functions obtained from the simulated launch of January 19, 1962, and the launch attempt of January 27, 1962, are also shown. These are plotted coincident with significant events. Pulse and respiration rates were determined by counting the rates for 30 seconds every 3 minutes until ten minutes prior to lift-off, and thereafter, 30 second duration counts were made each minute.

The pulse rates during the scrubbed flight countdown of January 27 varied from 60-80 beats/minute with a maximum of 88 beats/minute. These were essentially the same as those observed during the MA-6 countdown, as shown in figure 7.2.3.3-1. Respiration rates were similar, varying from 12-20 breaths/minute. Blood pressure values from the simulated launch also approximated those observed during the MA-6 countdown.

The increase in pulse rate to 110 beats/minute and blood pressure to 135/90 observed prior to lift-off can be attributed to anticipation.

The low suit inlet temperature maintained during countdown resulted in the pilot feeling cold and was accompanied by a fall in body temperature from 98.5° to 97.6°F.

An examination of the electrocardiographic wave form obtained during the MA-6 countdown revealed a number of variations in the pacemaker activity (point where the stimulus of the heart beat originates). These included sinus pauses, sinus bradycardia, premature atrial and nodal beats, premature ventricular beats, and a brief (16 beats) run of nodal rhythm. On several instances some of these reported findings occurred with deep respiration. Similar findings were recorded from the simulated launch of January 19 and from the scrubbed flight of January 27. These are considered normal physiological variations.

Samples of MA-6 records from the time of insertion, and at T-50 seconds, are shown in figures 7.2.3.3-2 and 7.2.3.3-3.

7.2.3.4 Flight. Figure 7.2.3.4-1 depicts the inflight physiological data and includes values from the Mercury-Atlas Three Orbit Centrifuge Simulation for comparison. Pulse rates were counted every 30 seconds during MA-6 launch and reentry and for 30 seconds at three minute intervals throughout the remainder of the flight. Due to irregularity in the respiratory recording, rates were counted for 30 seconds whenever quality permitted and varied from 8-19 breaths/minute throughout flight.

The pulse rate from lift-off to spacecraft separation (powered flight phase) reached a maximum of 110 beats/minute. The pulse rate varied from 88-114 beats/minute in the first 10 minutes of weightlessness. It then remained relatively stable with a mean rate of 86 beats/minute during the next 3 hours and 45 minutes of flight. At the time of retrorocket firing the rate was 96 beats/minute and during reentry deceleration and the return to gravity the highest rate was 134 beats/minute just prior to drogue deploy at a time of maximum spacecraft instability. This rate was the highest noted during the mission except for that during exercise as discussed below. These rates are within accepted ranges and suggest that acceleration, weightlessness, deceleration and return to gravity were within tolerable limits.

The ECG variations noted during the preflight observation period were not observed in flight, and analysis revealed only normal sinus rhythm with short periods of sinus bradycardia (slowing) and sinus arrhythmia (variation). There were rare periods where trace quality deteriorated so that only pulse rate determinations were possible. ECG variations noted during the Mercury-Atlas Three Orbit Centrifuge Simulation included: sinus arrhythmia, sinus bradycardia, atrial and nodal premature beats, and rare premature ventricular contractions. These are considered normal physiological variations.

Blood pressure determinations were made at times in flight; the first at 00:18:30 and the last at 03:14:00. The values are shown in figure 7.2.3.4-1 and range from 123-143 mm Hg systolic to 58-82 mm Hg diastolic. The mean blood pressure values for the periods of Mercury-Atlas Three Orbit

Centrifuge Simulation, countdown, and flight are presented in the following table:

	Mean Value	Systolic Range	Diastolic Range
3-Orbit Atlas	114/80 mm Hg	92 - 136 mm Hg	68 - 92 mm Hg
Centrifuge	114/80 mm Hg	92 - 136 mm Hg	68 - 92 mm Hg
Countdown	125/89 mm Hg	105 - 145 mm Hg	82 - 92 mm Hg

Inflight 131/69 mm Hg 118 - 144 mm Hg 51 - 87 mm Hg

The inflight mean value shows widening of the pulse pressure (difference between systolic and diastolic levels) when compared to the centrifuge and countdown levels. The mean blood pressure value from static Procedures Trainer simulations was 120/73. The widened pulse pressure is of uncertain physiological significance and more information is needed before conclusions can be reached.

Samples from the inflight record are shown in figures 7.2.3.4-2 through 7.2.3.4-4.

The inflight exercise device is illustrated in figure 7.2.3.4-5. Exercise was accomplished by a series of pulls on the elastic bungee cords. An exercise period over Zanzibar on the first orbit raised the pilot's pulse rate from 88 beats/minute to 134 beats/minute after 30 seconds. The pulse rate returned to 84 beats/minute within two minutes. The blood pressure was 129/70 mm Hg both before and after exercise.

The Environmental Control System effectively supported the pilot throughout the mission. It should be noted, however, that body temperature gradually rose from a lift-off value of 97.6°F to 99.2°F at bioplug disconnect. The suit inlet temperature increased slowly during most of the flight with a more rapid rise after reentry and during parachute descent. During descent the suit inlet temperature increased 1°F/minute for a 15 minute period and probably contributed to the pilot's overheated status observed at egress. No abnormally high body temperature was observed.

- 7.2.3.5 Pilot inflight observations. - The astronaut's voice reports were consistently accurate, confident, and coherent through all phases of the flight. His voice quality conveyed a sense of continued well being. His mental state appeared entirely appropriate for the situation. Furthermore, the pilot's mood and level of performance was effectively conveyed by his voice reports. His prompt responses to ground transmissions and to sounds from the spacecraft suggest no decrement in hearing ability. Visual acuity was maintained and his report of visual perceptions, especially with regard to colors, was accurate and was confirmed by the inflight photographs.

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The pilot's voice report contained a large number of observations of physiological significance. During his postflight debriefing these reports were amplified. Those considered of the most significance are discussed below.

No disturbances in spatial orientation were reported, nor were any symptoms suggestive of vestibular (inner ear) disturbances described during the flight. Voluntary rapid head turning movements produced no unpleasant sensations.

A brief sensation of tumbling forward occurred just after SECO (similar to that described by the astronauts in the MR-3 and MR-4 missions). This sensation ended promptly and was not associated with nausea. Coincident with retrorocket firing, a feeling of movement opposite from flight direction ("back to Hawaii") was noted. This could be expected with the sudden change in spacecraft velocity.

Food chewing and swallowing was accomplished without difficulty. No water as such was ingested during flight.

The pilot urinated without difficulty shortly before reentry. He described "normal" sensations of bladder fullness with the associated urge to urinate.

The pilot noted no difference in the sensations associated with reentry accelerations from those experienced during launch.

The astronaut described weightlessness as a "pleasant" sensation. Control manipulation was not a problem, and there was no observable performance decrement. The restraint harness-couch combination was reported to be comfortable.

In summary, the MA-6 mission provided a period of extended weightlessness during which the Astronaut's physiological responses apparently stabilized. The values attained were within ranges compatible with normal function. No subjective abnormalities were reported by the pilot.

7.2.4

Conclusions.-

(a) The physiological responses observed during the MA-6 mission are all consistent with intact, normal function.

(b) The preflight and postflight medical evaluations revealed no significant differences and were completely within normal limits with the exception of moderate dehydration.

(c) The MA-6 mission provided an exposure to weightlessness of sufficient duration to permit physiological responses to reach a relatively steady state.

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(d) No symptoms reflecting disturbed vestibular (inner ear) function were reported. This lack of findings occurred even though specific attempts were made to stimulate the vestibular organ in flight.

(e) Four hours and thirty-eight minutes of weightlessness were tolerated without observable performance decrement.

(f) The pilot's subjective evaluation of his body processes and sensations during the flight all conveyed normal function.

(g) Acceleration - weightlessness transition periods did not produce any recognized physiological deterioration. Specifically, re-entry acceleration after 4 hours and 38 minutes of weightlessness did not produce any unexpected symptoms, and physiological data remained within anticipated limits.

(h) The Environmental Control System effectively supported the pilot throughout the mission.

(i) The astronaut's apparent fatigue noted in the immediate post-flight evaluation can be attributed to a number of factors. The most logical explanation is dehydration following overheating plus the cumulative effects of the various stresses experienced in the pre and inflight periods.

(j) His mild gastrointestinal discomfort ("stomach uneasiness") which occurred after landing may likewise be attributed to the increased environmental temperature and moderate dehydration of the astronaut. The motion of the spacecraft on the sea may be a contributory factor. This sensation cleared after a brief period of rest and rehydration.

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TABLE 7.2.1-1.- SIGNIFICANT EVENTS PRIOR TO LAUNCH

(all times e.s.t.)

DATE	TIME	EVENT
February 19, 1962	2130	Retired
February 20, 1962	0220	Awakened and showered
	0250	Breakfast
	0305	Physical examination
	0428	Suiting started
	0505	Entered transfer van
	0520	Arrived at Pad 14 and remained in transfer van
	0558	Ascended gantry
	0606	Insertion
	0625	Countdown resumed
	0947	Launch

Astronaut Glenn began his 72-hour, prelaunch low residue diet on February 16, 1962. On the night prior to flight, the pilot obtained 4 hours and 50 minutes of dozing, light sleep. No medication was administered.

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8.0 FLIGHT CONTROL AND NETWORK PERFORMANCE

- 8.1 Network description. - The Mercury Network consists of the Mercury Control Center (MCC) at Cape Canaveral (CIV), stations at Atlantic Missile Range (AMR), Bermuda (BDA), and at fourteen other locations along the orbital ground track, plus communications and computing centers at the Goddard Space Flight Center. The Network affords the capability of data acquisition for real-time monitoring and mission control, and for postflight analysis.
- 8.2 Flight control summary. - This summary presents the results of the flight as determined in real time. It is recognized that the results may be different from those obtained from an analysis of the data and presented in other sections of this report.

The launch and insertion into orbit very closely approximated nominal conditions. The pilot's performance throughout the flight was excellent, and he was able to deal with the unusual situations which arose. Several problems developed in the spacecraft automatic control system. The ASCS system was unable to maintain the spacecraft within the preset attitude limits about the yaw axis after approximately one orbit because of lack of thrust from the 1-pound yaw thrusters. This same malfunction was reflected in the system's operation when the astronaut elected to control with the fly-by-wire mode; however, he was able to maintain satisfactory attitude control about the yaw axis by using the larger thrusters. The horizon scanner and gyro reference system appeared to be in error mainly in the roll axis while the spacecraft was on the dark side of the earth. The manual-proportional control system worked well throughout the flight. The cooling system for both main inverters appeared to be inoperative throughout the entire flight and the inverter temperatures reached values as high as 210 to 220°F; however, no inverter malfunctions occurred.

On the first pass over Canaveral, segment 51 of the commutator showed a signal indication which, if correct, indicated that the spacecraft heat shield had been deployed. A great deal of analysis and discussion followed and a decision was first made that the signal, although a correct telemetry output, was the result of a faulty switch and that the normal sequence of events should be followed. Further discussion, however, indicated that

the safest approach would be to allow the retropackage to remain on. The retropackage straps would then hold the heat shield in place until sufficient dynamic force was exerted on the shield to maintain its position throughout reentry heating. The opinion was that the heat effects of the retropackage on the capsule heat shield and afterbody would not be damaging. Therefore, the pilot was directed during the retrofire maneuver over CAL to keep the retrojet switch in the disarm position. The successful reentry proved this to be a sound decision. The remainder of the flight was nominal and no other major system malfunctions occurred. It must be strongly emphasized that although the malfunctions which did occur were minor with a pilot in the spacecraft to make decisions and take corrective action, these malfunctions would have made an unmanned flight extremely difficult to handle and may possibly have resulted in the inability to reenter the spacecraft and obtain successful recovery.

1.8

Flight control summary. - This summary presents the results of the flight as determined in real time. It is recognized that the results may be different from those obtained from an analysis of the data and presented in other sections of this report.

S.8

The launch and insertion into orbit very closely approximated nominal conditions. The pilot's performance throughout the flight was excellent, and he was able to deal with the unusual situations which arose. Several problems developed in the spacecraft automatic control system. The ASCS system was unable to maintain the spacecraft within the preset attitude limits about the yaw axis after approximately one orbit because of lack of thrust from the 1-pound yaw thrusters. This same malfunction was reflected in the system's operation when the astronaut elected to control with the fly-by-wire mode; however, he was able to maintain satisfactory attitude control about the yaw axis by using the larger thrusters. The horizon scanner and gyro reference system appeared to be in error mainly in the roll axis while the spacecraft was on the dark side of the earth. The manual-proportional control system worked well throughout the flight. The cooling system for both main inverters appeared to be inoperative throughout the entire flight and the inverter temperatures reached values as high as 210 to 220°F; however, no inverter malfunctions occurred.

On the first pass over Canaveral, segment 21 of the commutator showed a signal indication which, if correct, indicated that the spacecraft heat shield had been deployed. A great deal of analysis and discussion followed and a decision was then made that the signal, although a correct telemetry output, was the result of a faulty switch and that the normal sequence of events should be followed. Further discussion, however, indicated that

- 8.3 Network performance summary. - Generally, the Network performance was excellent. All systems were fully operational at lift-off and the few minor malfunctions did not affect the flight monitoring and control of the mission. Acquisition of data from tracking, telemetry, and air/ground voice systems was satisfactory in both quantity and quality for real-time monitoring and for postflight analysis. The relaying of air/ground voice back to the Mercury Control Center from all sites which have point-to-point voice capability contributed, substantially, in enabling MCC to maintain close real-time monitoring of the mission.
- 8.3.1 Trajectory. - The following paragraphs discuss details of tracking, data transmission, computing, and trajectory displays.

Tracking. - The radar tracking on this flight was satisfactory and was superior to that of MA-4 or MA-5. All sites provided data for all passes whenever the spacecraft was above their horizon. The quantity and quality of data were more than adequate. Minor problems existed in S-band phasing and handover, but this caused negligible loss of data; the communications used for this were satisfactory. Interference, source unknown, caused some concern on C-band at Canaveral and Bermuda, but did not cause any extensive loss of data. It is apparent that the extensive maintenance, training, and work on tracking procedures throughout the Network has paid dividends. Satisfactory C-band tracking was accomplished during most of the "blackout" period. Two Cape radars had satisfactory S-band tracking for the first two minutes of blackout and were then turned off, having reached the end of their range interval.

Radar-tracking coverage is shown in figure 8.3.1-1. Details of the acquisition aid performance are not currently available. However, acquisition was in all cases satisfactory.

Data transmission. - The transmission of both high speed and low speed data was satisfactory throughout the mission.

Computing and trajectory displays. - At lift-off, the selected source for display at the MCC was the output of the IP 7090. Cape FPS-16 tracking was utilized until approximately 00:00:50 when the IP 7090 switched to AZUSA. AZUSA was displayed for approximately the next 20 seconds, at which time GE-Burroughs via Goddard was selected and was displayed throughout the powered flight. The GE radar acquired both rate and track at 00:01:08 and never lost lock throughout the powered flight. The quality of the GE data was excellent up to SECO and during the GO-NO-GO computation.

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The programed phase of the flight showed a minor deviation of $+0.75^\circ$ in flight-path angle, and $+1.0$ n.m. in altitude, at BECO. After staging, steering corrected this deviation in both altitude and flight-path angle. A maximum deviation of $+2.8$ n.m. in crossrange, and a residual of $+50$ fps in yaw velocity existed at cutoff. The yaw velocity looked very good up to approximately 35 seconds before cutoff, then appeared to lack response to steering with the final results as stated above. There appears to be conflicting evidence on this particular point since the calculated impact point at the Canary Islands (CYI) was right on the expected ground track, which is difficult to resolve with a residual velocity of 50 fps in yaw. This matter will be further investigated. The cutoff conditions displayed in MCC are listed in table 8.3.1-1.

Low-speed tracking data from the remote sites were excellent, such that the orbit was well defined by the end of the first orbit. Subsequent tracking in the second and third orbits showed negligible changes in the orbit parameters. The number of radar observations received from each site is shown in table 8.3.1-2.

The "A" computer was lost during the second orbit between Hawaii (HAW) and California (CAL). A restart was made in less than 5 minutes using the HAW vector, thus the computer was ready to accept the White Sands (WHS) data. A "B" computer malfunction caused the Texas (TEX) and Eglon (EGL) data on Orbit 2 and EGL data on reentry to be ignored.

During the reentry, tracking data appeared to pinpoint the landing location with a high degree of confidence, and the final values from the Goddard computers indicated only 2 n.m. difference between the landing location as obtained from CAL data and from the Cape FPS-16 data (see table 8.3.1-3). However, the landing point as reported by the recovery ship, and as computed by the Cape IP 7090 computer using Cape and San Salvador FPS-16 data, does not agree with the Goddard computations. The discrepancies between the Cape and Goddard computations have not been resolved at this writing, but are being investigated.

The low-frequency cyclic noise pattern was apparent in both GE-Burroughs and AZUSA data but slightly lower in amplitude than in MA-5 and much lower than MA-4. At insertion GE gave an inertial velocity of 25,727.6 feet/second and an inertial flight-path angle of -0.0674 degrees, while AZUSA figures were 25,733.3 and -0.0907 , respectively.

The performance of the computing system and the tracking facilities was excellent throughout the mission.

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8.3.2

Telemetry. - The data provided by the telemetry system was generally adequate and of good quality. Coverage was satisfactory, with data acquisition throughout each pass at every site when above the radio horizon. Coverage is shown graphically in figure 8.3.2-1 (a, b, and c) and in tabular form with decommutator figures, range and elevation in table 8.3.2-1. Signal strengths were satisfactory, ranging up to 400 microvolts. Several sites reported low signal levels, as compared with previous missions.

Ionization "blackout" of telemetry began at approximately 04:42:52, as seen at Canaveral, and ended at approximately 04:47:14, as seen at Grand Turk. Thus the period lasted 4 minutes and 22 seconds. Data flow charts were drawn up based on the telemetry summary messages from the sites. The majority of the data points fall within $\pm 3\%$ of a faired curve. A few exceptions were evident, however, in that figures from several sites were consistently off the faired curves of fuel quantity by as much as 10%. See figure 8.3.2-2.

Figure 8.3.2-1 shows approximate coverage, compared with time above the visual horizon. Through the air-ground voice system, MCC was able to follow the recovery procedure, monitoring all conversations until after the spacecraft was aboard the recovery ship.

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8.3.3 Air/ground voice. - The performance of the primary air/ground voice system (UHF system) was good throughout the mission. Signal strengths were adequate to provide very good signal-to-noise ratios essentially at all times the spacecraft was above the local visual horizon at the network sites. In most instances, the RF refraction increased the coverage over visual line-of-sight by one to two minutes. UHF in-range times averaged almost seven minutes during a pass.

The HF voice system provided some additional coverage, though (as expected) not as satisfactory as UHF. HF was of particular value on the first and third orbits where Canary, California, Guaymas, Zanzibar, Indian Ocean Ship, Muchea, and Canton were able to converse with the astronaut beyond the capability of the UHF system.

It is interesting to note that in some instances where the HF was being used as the spacecraft approached the station, the quality of communications improved considerably as the elevation angle became positive, particularly as the switch was made to UHF.

Figure 8.3.3-1 shows approximate coverage, compared with times above the visual horizon. Through the air/ground voice system, MCC was able to follow the recovery procedure, monitoring all conversations until after the spacecraft was aboard the recovery ship.

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8.3.4

Command System.- The command system for MA-6 operated in a generally satisfactory manner during the mission. Some airborne-system anomalies are discussed below. A preliminary evaluation of the data shows that the 600-watt stations appeared to have coverage beginning at a slant range of 400-450 N.M., and that the 10 KW stations appeared to have coverage beginning at a slant range of 650-700 N.M. A summary of the command handover exercises is shown in Table 8.3.4-1, and a summary of the command transmissions is shown in Table 8.3.4-2.

Ground System.- There were several problems involving the command equipment and the coder relay panels during the month prior to launch; however, no delays in the launch countdown resulted.

A total of eleven (11) functions were successfully transmitted from the sites: Auxiliary Sustainer Cutoff (ASCO) was transmitted from San Salvador, three sets of R and Z calibrations were transmitted from Muchea, and two sets of R and Z calibrations were transmitted from Cape Canaveral.

Command coverage from all sites was satisfactory with the exception of Muchea on the third pass. A combination of slant ranges in excess of 450 nautical miles, airborne antenna patterns, and only 600 watts of RF power resulted in only one minute and 30 seconds of coverage above receiver threshold.

Airborne System.- Command Receiver "A", operating from the 18-volt isolated bus, appeared to be much more sensitive to signal strengths above 30 microvolts than Receiver "B", which operates from the 18-volt standby bus. Below 30 microvolts, both receivers' operation coincided. Generally, the onboard recorded signal strengths were about 6 db lower than on the MA-4 and MA-5 missions. The reason for the difference in recorded signal strengths is not known at this time. The airborne antenna pattern problem, which was experienced on MA-4 and MA-5, was again evident from the MA-6 onboard records. Spacecraft attitude changes are definitely reflected on the signal strength records.

Ionization blackout occurred on the Command frequency between 04:43:03:5 GET and 04:47:12 GET.

The following anomalies were experienced, and are being investigated:

(a) Triggering of the "All Function Events Channel" occurred five times during ionization blackout. The tone channels triggered are unknown, but are coincident with burst of signal into the receivers. It is known that the tones keyed were not clock changes, R and Z calibrations, or Mayday. The characteristics of the inputs to the command receiver are shown in the oscillograph record reproductions of figures 8.3.4-1 through 8.3.4-3.

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(b) What is assumed to be random noise with a signal strength from one to 4 microvolts was recorded between 01:14:00 GET to 01:15:07 GET. Command carrier was not present during this period.

The 600-watt stations appeared to have coverage range of 400-450 N.M., and that the 10 KW stations appeared to have coverage beginning at a slant range of 650-700 N.M. A summary of the command handover exercises is shown in Table 8.3.4-1, and a summary of the command transmissions is shown in Table 8.3.4-2.

Ground System - There were several problems involving the command equipment and the code relay panels during the month prior to launch; however, no delays in the launch countdown resulted.

A total of eleven (11) functions were successfully transmitted from the sites: Auxiliary Sustainer Cutoff (ASCO) was transmitted from San Salvador, three sets of R and S calibrations were transmitted from Maches, and two sets of R and S calibrations were transmitted from Cape Canaveral.

Command coverage from all sites was satisfactory with the exception of Maches on the third pass. A combination of slant ranges in excess of 450 nautical miles, airborne antenna patterns, and only 600 watts of RF power resulted in only one minute and 30 seconds of coverage above receiver threshold.

Airborne System - Command Receiver "A", operating from the 18-volt isolated bus, appeared to be much more sensitive to signal strength above 30 microvolts than Receiver "B", which operated from the 18-volt standby bus. Below 30 microvolts, both receivers' operation coincided. Generally, the onboard recorded signal strengths were about 6 db lower than on the MA-4 and MA-5 missions. The reason for the difference in recorded signal strength is not known at this time. The airborne antenna pattern problem, which was experienced on MA-4 and MA-5, was again evident from the MA-6 onboard records. Spacecraft attitude changes are definitely reflected on the signal strength records.

Ionization blackout occurred on the Command frequency between 04:43:03.2 GET and 04:47:12 GET.

The following anomalies were experienced, and are being investigated:

(a) Triggering of the "All Function Events Channel" occurred five times during ionization blackout. The four channels triggered are unknown, but are coincident with burst of signal into the receivers. It is known that the tones keyed were not clock changes, R and S calibrations. The characteristics of the inputs to the command receiver are shown in the oscillograph record reproductions of Figures 8.3.4-3 and 8.3.4-4.

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8.3.5

Ground communications. - All the ground communications networks provided good support for the mission. Except for a few short prelaunch outages, all the voice, teletype, and datalines were available at all times, and the quality of transmission was satisfactory.

Single-sideband voice communication with the two ships was very satisfactory, as provided by AMR. Part of the link from the Indian Ocean Ship had to be relayed through ascension.

1.0000	1.0000	Velocity ratio with postages (Av. of 00-00-00)
0.0013	0.0013	Inertial flight path angle (Av. of 00-00-00)
86.4 n.m.	86.4 n.m.	Insertion altitude (Av. of 00-00-00)
35.2%	35.2%	Inclination angle
	*	Orbit capability
52.138 lbs	52.138 lbs	Insertion velocity with postages
144 n.m.	144 n.m.	Apogee altitude

*Maximum number computed; actual orbit capability was approximately 100 orbits.

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TABLE 8.3.1-1-1-ORBITAL INSERTION CONDITIONS
 DISPLAYED AT MCC

Quantity	Actual	Nominal
Velocity ratio with posigrades (Av. of GO-NO-GO)	1.0002	1.00058
Inertial flight-path angle (Av. of GO-NO-GO)	$-.0674^{\circ}$	$-.0013^{\circ}$
Insertion altitude (Av. of GO-NO-GO)	86.4 n.m.	86.98 n.m.
Inclination angle	32.54°	32.5°
Orbit capability	7*	
Insertion velocity with posigrades	25,728 fps	25,736 fps
Apogee altitude	141 n.m.	144 n.m.

*Maximum number computed; actual orbit capability was approximately 100 orbits.

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TABLE 8.3.1-2.- SUMMARY OF LOW-SPEED TRACKING DATA

1st Pass						2nd Pass					3rd Pass				
Total						Total					Total				
Poss.						Poss.					Poss.				
Valid	Total	Non-				Valid	Total	Non-				Valid	Total	Non-	
Obs.	Obs.	Valid	Valid	DC*		Obs.	Obs.	Valid	Valid	DC*		Obs.	Obs.	Valid	Valid
BDA-16	71	56	53	3	43	66	56	47	9	42	65	60	58	2	49
BDA-V	71	61	53	8		DATA NOT AVAILABLE					DATA NOT AVAILABLE				
CYI-V	68	72	63	9	50	54	54	46	9	34	OUT OF RANGE				
MUC-V	82	93	76	17	50	80	61	60	1	50	70	69	65	4	50
WOM-16	40	85	40	45	40	33	65	29	36	29	OUT OF RANGE				
HA-16	OUT OF RANGE					15	15	15	0	15	40	38	38	0	38
HA-V	OUT OF RANGE					56	34	30	4		64	23	14	9	
CAL-16	OUT OF RANGE					38	29	28	1	28	42	20	17	3	17
CAL-V	OUT OF RANGE					DATA NOT AVAILABLE					DATA NOT AVAILABLE				
GY-V	65	64	51	13	44	PASSIVE					PASSIVE				
WHS-16	34	56	28	28	28	41	63	31	32	31	41	61	34	27	34
TR-V	64	71	46	25	0	60	64	60	4	47	53	60	54	6	41
EGL-16	40	39	38	1	38	40	42	41	1	38	40	23	22	1	18
EGL-V	DATA NOT AVAILABLE					DATA NOT AVAILABLE					DATA NOT AVAILABLE				
CNV-16		71	43	28	35		58	54	4	44		33	27	6	22

* Differential Correction

NOTE: Verloort not used in DC after correction on FPS-16

V - Verloort (S-band)

16 - FPS-16 (C-band)

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TABLE 8.3.1-3.- SUMMARY OF LANDING-POINT PREDICTIONS
BASED ON RADAR TRACKING

CONDITION*	LATITUDE	LONGITUDE
1. Retrofire time confirmed by CAL	21°08'N	68°01'W
2. DC on CAL tracking	21°32'N	68°55'W
3. DC on WHS tracking	21°29'N	68°48'W
4. DC on TEX tracking	21°29'N	68°48'W
5. DC on EGL tracking	21°31'N	68°53'W
6. DC on CNV tracking	21°31'N	68°53'W
Cape IP 7090 impact data:		
1. Based on Cape FPS-16 tracking	21°21'N	68°31'W
2. Based on San Sal FPS-16 tracking	21°24'N	68°35'W
Value reported by recovery	21°25'N	68°37'W

*DC - Differential correction

12 - 128-12 (C-128)

1 - 128-12 (C-128)

NOTE: All data are based on DC data collection.

* Differential correction

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TABLE 8.3.2-1. TELEMETRY RECEPTION SUMMARY

ORBIT I

Station	TM Acq.	TM LOS	Decommutator Lock On	Decommutator LOS	Slant Range N.M.	Elevation degrees
					Acq. LOS	Acq. LOS
CNV	00:00:00	00:06:20	00:00:00	00:07:30*	750	0
BDA	00:03:02	00:10:26	00:03:40	00:10:26	750	-1.2
ATS	NOT IN RANGE					
CYT	00:14:15	00:21:23	00:14:41	00:21:20	800	0
KNO	00:21:13	00:28:21	00:21:50	00:28:21	850	-3
ZZB	00:29:51	00:37:51	00:30:01	00:38:01	920	-2
IOS	00:40:02	00:48:31	00:43:12	00:46:56	1000	-6
MUC	00:49:21	00:57:55	00:49:32	00:51:21	1020	-4
WOM	00:54:00	01:02:41	00:54:16	01:02:37	810	+3
CTN	01:09:19	01:17:42	01:09:36	01:17:40	900	+3
HAW	NOT IN RANGE					
CAL	01:26:41	01:31:23	01:27:18	01:31:23	840	-7
GYM	01:26:47	01:33:25	01:27:01	01:33:15	730	+9
TEX	01:29:24	01:36:18	01:29:32	01:36:14	830	-7
EGL	01:32:00	01:37:05	01:32:11	01:37:00	800	-1

*Includes data from downrange via submarine cable.

TABLE 8.3.2-1- TELEMETRY RECEPTION SUMMARY (Continued)

ORBIT II

Station	TM Acq.	TM LOS	Decommutator Lock On	Decommutator LOS	Slant Range Acq.	Slant Range N.M.	Elevation degrees
CNV	01:33:20	01:40:03	01:33:27	00:01:41:00*	840	850	0
BDA	01:36:38	01:43:53	01:36:49	04:01:43:53	860	890	-1.2
ATS	01:51:54	01:58:31	01:53:04	01:58:21	880	830	-2
CYT	01:47:55	01:53:58	01:48:11	01:53:53	850	910	-2
KNO	01:54:47	02:01:21	01:55:07	02:01:21	890	940	-6
ZZB	02:04:05	02:10:51	02:04:13	02:10:51	920	1040	.23
IOS	02:12:17	02:22:09	02:13:27	02:21:54	1100	1050	-1.9
MUC	02:22:51	02:31:23	02:23:06	02:31:22	1008	960	-3
WOM	02:27:36	02:35:45	02:27:45	02:35:39	950	1020	+5
CTN	02:42:51	02:49:45	02:42:59	02:49:38	870	907	-1.5
HAW	02:49:01	02:55:19	02:49:29	02:55:08	940	830	-1.3
CAL	02:58:11	03:04:48	02:58:35	03:04:48	880	730	-1.5
GYM	02:59:59	03:06:44	03:00:13	03:06:34	610	880	+3
TEX	03:03:14	03:09:39	03:03:16	03:09:31	810	810	-8
EGL	03:05:35	03:12:07	03:05:46	03:12:00	670	1000	+2

*Includes data from downrange via submarine cable.

TABLE 8.3.2-1.- TELEMETRY RECEPTION SUMMARY (Concluded)

ORBIT III

Station	TM	TM	Decommutator Lock On	Decommutator LOS	Slant Range		Elevation	
	Acq.	LOS			N-M.	LOS	degrees	Acq. LOS
CNV	03:06:51	03:13:46	03:06:53	03:15:42*	780	920	0	0
BDA	03:09:56	03:17:03	03:10:06	03:17:03	870	900	-1.2	-1.2
ATS	03:24:44	03:32:25	03:25:06	03:31:22	900	920	-5	+5
CYT	NOT IN RANGE							
KNO	NOT IN RANGE							
ZZB	NOT IN RANGE							
IOS	03:46:55	03:56:49	03:48:10	03:56:30	1050	1100	-1.4	-1.4
MUC	03:56:31	04:04:12	03:56:49	04:04:08	1020	940	-7	-16
WOM	04:03:16	04:06:19	04:03:31	04:06:01	870	1000	+1	-1.4
CTN	N/A							
HAW	04:21:49	04:28:49	04:22:02	04:28:39	920	770	-2	+1
CAL	04:31:17	04:37:57	04:31:27	04:37:56	900	540	-2	+3.6
GYM	04:33:44	04:39:49	04:34:04	04:39:39	770	740	-5	-1.1
TEX	04:36:53	04:42:32	04:36:58	04:42:34	930	603	-3	-5
EGL	04:39:00	04:42:52	04:39:21	04:42:48	800	500	-1	+1.4
CNV	04:40:52	04:42:55	04:40:56	04:42:53	590	150	+1	+17
CNV	--	--	04:47:22**	04:50:10**	--	--	--	--

*Includes data from downrange via submarine cable.

**Data from downrange via submarine cable

TABLE 8.3.4-1.- COMMAND HANDOVER SUMMARY

III

Station	Command Handover Plan		Actual Handover		Maximum Signal Recorded in Microvolts	
	ON	OFF	ON	OFF		
Canaveral (H)		00:06:00		00:06:01	65	
Bermuda (H)	00:05:58	00:12:00	00:05:58	00:12:00	50	
Muchea (L)	00:45:00	00:59:00	00:45:00	00:59:00	21	
Guaymas (L)	01:20:00	01:33:00	01:20:00	01:33:00	28	
Canaveral (H)	01:33:00	01:38:00	01:33:03	01:38:01	65	
Bermuda (H)	01:37:58	01:45:00	01:37:58	01:45:00	65	
Muchea (L)	02:15:00	02:32:00	02:15:00	02:32:00	40	
Hawaii (H)	02:45:00	02:56:00	02:45:00	02:56:00	40	
California (H)	02:56:00	03:04:00	02:56:00	03:04:00	50	
Guaymas (L)	03:04:00	03:06:00	03:04:00	03:06:00	120	
Canaveral (H)	03:06:00	03:12:00	03:06:04	03:12:03	55	
Bermuda (H)	03:12:00	03:18:00	03:12:00	03:18:00	150	
Muchea (L)	03:54:00	04:05:00	03:54:00	04:05:00	12	
Hawaii (H)	04:15:00	04:30:00	04:15:00	04:30:00	50	
California (H)	04:30:00	04:38:00	04:30:00	04:30:00	50	
Guaymas (L)	04:38:00	04:40:00	04:38:00	04:40:00	13	
Canaveral (H)	04:40:00	04:45:45	04:40:07	04:45:53	50	
San Salvador (H)	04:45:45	04:50:50	04:45:52	04:50:57	45	
(H) 10 KW RF Power	04:58:33	04:58:33	04:58:33	04:58:33	04:58:33	
(L) 600 Watts RF Power	04:58:33	04:58:33	04:58:33	04:58:33	04:58:33	
1.1- 2-	04:58:33	04:58:33	04:58:33	04:58:33	04:58:33	
2- 3-	04:58:33	04:58:33	04:58:33	04:58:33	04:58:33	
4.1+ 1-	04:58:33	04:58:33	04:58:33	04:58:33	04:58:33	
11+ 1+	04:58:33	04:58:33	04:58:33	04:58:33	04:58:33	
-- --	04:58:33	04:58:33	04:58:33	04:58:33	04:58:33	

*Data from downrange via submarine cable.
 **Data from downrange via submarine cable.

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TABLE 8.3.4-2.- COMMAND FUNCTION SUMMARY

Station	*Function	Time/Duration of Function	Successfully Received	Airborne-Receiver Signal Strength in Microvolts
San Salvador	ASCO	00:05:01.7/4 Sec	Yes	20
Muchea	Z Cal	00:51:47.5/21 Sec	Yes	16
Muchea	R Cal	00:52:14/32 Sec	Yes	17
Canaveral	Z Cal	01:36:12/10 Sec	Yes	62
Canaveral	R Cal	01:36:24/14 Sec	Yes	64
Muchea	Z Cal	02:27:21/15 Sec	Yes	36
Muchea	R Cal	02:27:55/36 Sec	Yes	35
Canaveral	Z Cal	03:09:58/9 Sec	Yes	55
Canaveral	R Cal	03:10:09/11 Sec	Yes	53
Muchea	Z Cal	04:00:08/17 Sec	Yes	7
Muchea	R Cal	04:00:32.5/23 Sec	Yes	9

*ASCO - Auxiliary Sustainer Cutoff

R Cal - Instrumentation Full-scale Calibration

Z Cal - Instrumentation Zero Calibration

9.0 RECOVERY

- 9.1 Recovery plans. - Figure 9.1-1 shows the Atlantic recovery areas where ships and aircraft were positioned at the time of launch. Areas 1 through 6 were available in the event that it became necessary to abort the mission during powered flight. Recovery forces were distributed so as to provide for recovery within a maximum of 3 hours after landing in areas 1 and 4, and a maximum of 6 hours in areas 2, 3, 5, and 6. Areas 7, 8, and 9 were available for landing at the end of orbits 1, 2, and 3, respectively, and recovery forces were distributed to provide for recovery within a maximum of 3 hours. A total of 24 ships and 15 aircraft were on station in these Atlantic recovery areas at launch time. In addition, helicopters, amphibious surface vehicles and small boats were positioned for recovery support near the launch pad.

Figure 9.1-2 shows the contingency recovery aircraft that were on alert at various staging bases in the event that a landing occurred any place along the 3-orbit ground track. These aircraft were equipped to locate the spacecraft and to provide emergency on-scene assistance if required.

- 9.2 Recovery operations. - All recovery forces were on station at planned launch time. Weather conditions were favorable for location and retrieval in all Atlantic recovery areas and were good in contingency areas. Recovery communications were good throughout the entire operation and the recovery forces were informed of mission status during the launch, orbital, and reentry phases.

During the third orbit, recovery units in area 9 were alerted to expect a landing in their area and at 04:42:00 (13 minutes prior to landing) were informed that the landing was calculated to occur at 21°29' north latitude and 68°48' west longitude. This information was transmitted to the recovery forces as CALREP 1 (calculated landing position report), see figure 9.2-1. Continued radar tracking made little change in this prediction and at 04:46:00 (9 minutes prior to landing) the recovery forces were directed to orient their search about this position. This information was transmitted as DATUMREP 1, indicating that this was the best landing position information available at that time. In the meantime, lookouts on the destroyer NOA stationed in the DD16 position heard a noise like an explosion, and approximately 20 seconds later, the main parachute and spacecraft were sighted at an estimated slant range of 5 miles and elevation angle of 35°. The noise was described as similar to the "sonic-boom" noise made by aircraft traveling at supersonic speeds.

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The NOA established communications with the astronaut and at 05:07:00 (12 minutes after landing) was alongside the spacecraft. The astronaut remained in the spacecraft during retrieval.

Photographs of the spacecraft prior to and during retrieval are shown in figures 9.2-2 and 9.2-3. A "shepherd's crook" was used to attach a lifting line to the spacecraft which was hoisted clear of the water at 05:12:00 and secured on the recovery ship at 05:15:00 (20 minutes after landing).

The astronaut first decided to egress from the spacecraft through the top, and began the standard procedure of removing the right-hand instrument panel. However, considering the time and effort normally associated with this egress route and the fact that he was uncomfortable, he elected to egress by the quicker route through the side hatch. He actuated the side hatch explosive mechanism from inside the spacecraft, and was clear of the spacecraft at 05:34:00 (39 minutes after landing).

The following retrieval information was reported by the recovery ship:

Position of pickup - 12°25.6' North; 68°36.5' West

Winds - 18 knots from 119° true

Waves - 2 feet

Water temperature - 81°F

Air temperature - 75°F

9.3 Recovery aids. - All spacecraft recovery aids apparently functioned normally.

Search aircraft reported contact with both SARAH recovery beacons and with the UHF transceiver. These aircraft were proceeding towards the calculated landing position at this time and were well within the available range of these systems.

The dye marker and flashing light were reported to be functioning normally.

The SOFAR bomb signal was received and a fix was available at the recovery center about one hour after landing. This fix was approximately 4 miles from the spacecraft retrieval position as shown in figure 9.2-1.

The SEASAVE beacon fixes as reported by the Navy and FCC HF/DF networks are shown in figure 9.2-1. The first fix was available at the recovery center at 05:20:00. A later fix was available at 05:27:00. Both fixes were about 25 nautical miles from the retrieval point.

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10.0 APPENDIX

10.1 Spacecraft postflight inspection.-

General condition.- The general condition of the spacecraft interior and exterior was excellent. (See figure 10.1-1). The exterior of the spacecraft showed the usual slight discoloration due to aerodynamic heating. Also, there were deposits of 2024 aluminum alloy, which had evidently been deposited in a molten state, adhering to the surface of several widely separated shingles. It is likely that the aluminum retropack cover is the source of these deposits.

A brownish deposit was found on a portion of the spacecraft window exterior surface. The nature of this deposit has not been determined. As on previous flights, the window was found to be fogged with water condensate between the two outer panes.

Structure.- The spacecraft did not experience any structural damage which would have compromised the safety of the mission.

Ablation shield.- The external surface of the shield (see figure 10.1-2) was charred in the normal pattern. The center plug of the shield had separated and extended outward approximately 0.5 inch, as in most of the previous missions. A pie-shaped segment of the shield is of a darker background color than the adjacent area. The same area contains several radial marks approximately 4 inches in length. It is likely that a large piece of the retropack slipped off in this direction. There are two small deposits, metal-like but of undetermined composition, on the shield.

Heat-shield deployment instrumentation.- The heat-shield deploy switch between stringers 2 and 3 had a very loose rotary stem. The switch would make and break electrical contact when the rotary stem was moved up and down along its longitudinal axis. This malfunction could account for the impact-bag-deployed signal that was received during the flight.

Landing bag.- The landing bag had several tears, and it was impossible to determine whether these occurred during impact or in postflight handling. No landing bag straps or cables were broken, but some straps were kinked. There was minor damage to the heat shield retaining studs and the bulkhead protective shield, probably from impact as in previous flights. However, no damage occurred to the spacecraft equipment in this area.

The large pressure bulkhead had a dent from an undetermined cause near the center approximately 1.5 inches long. The center area is not covered by the bulkhead shield.

10.2- Launch Operations.- The spacecraft launch operations were planned about a 610-minute split count with a 17½ hour built-in hold at T-390 minutes for spacecraft peroxide and pyrotechnic servicing. To provide additional assurance that the projected launch time of 0730 A.M. e.s.t., February 20, 1962, could be met, a 90-minute hold was scheduled at T-120 minutes.

The second half of the split count was picked up at 1130 P.M. e.s.t. on February 19, 1962. Launch was at 0947 A.M. e.s.t. on February 20, 1962, after two hours and 17 minutes of unplanned holds. The following is a sequence of important events, including holds, which occurred in the countdown:

T-390 min. Count was picked up.

T-120 min. Built-in 90-minute hold. Due to a sudden drop in the booster rate-beacon Automatic Gain Control the first backup beacon was substituted for the original during this 90-minute scheduled hold period. The hold was extended an additional 45 minutes to complete installation and re-validate the beacon.

An additional 10-minute hold was required by the spacecraft to replace a broken microphone bracket in the Astronaut's helmet.

T-120 min. Picked up count.

T-117 min. Completed second G.E. guidance loop test.

T-87 min. Started hatch installation.

T-60 min. A 40-minute hold was required to replace a broken bolt on the spacecraft hatch. A third G.E. guidance loop test was performed during this hold.

T-45 min. A 15-minute hold was required to add approximately 10 gallons of fuel to the booster.

T-22 min. A 25-minute hold resulted from a malfunction of the main ILOX fill pump outlet valve. The final 20% of ILOX tanking was accomplished by using a smaller pump via a 6-inch line, resulting in a slower operation.

T-6:30 min. A 2-minute hold was required by the Mercury Flight Director to investigate an outage in the source power to the Bermuda computer.

10.3 Weather conditions.- The weather conditions in the launch area at lift-off were as follows:

Cloud cover 0.2 Alto cumulus
 Visibility 10 miles
 Surface winds North at 18 knots (gusts to 25 knots)

A plot of the launch area wind direction and speed is shown in figure 10.3-1 for altitudes up to 60,000 feet.

Landing area weather conditions were as follows:

Cloud cover 0.2
 Visibility 10 miles
 Surface winds ESE at 14 knots
 Waves 2 feet

(d) Communications.- No outstanding problems were experienced with the communication equipment after the spacecraft arrived at Hanger "B". Headsets from the range on the C band radar beacon showed jitter and varying signal strength. These problems disappeared, as expected, when the service tower was removed.

(c) Electrical.-

(1) Flight batteries were activated on November 8, 1961. These batteries were replaced on February 10, 1962 when one battery cell lost voltage and another had a short to case.

(2) Both memory cell auxiliary battery units were replaced by new units on January 13, 1962.

(3) Inverter switching circuitry was modified to provide a non-fused circuit to the standby inverter in the manual mode.

(4) The original 120 VA inverter malfunctioned during a hangar test and was replaced.

(5) The [redacted] unit was replaced.

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10.4

Spacecraft History.-

Spacecraft No. 13 was delivered to Hangar "S", Cape Canaveral, Florida on August 27, 1961. Upon arrival, spacecraft entered a short work period during which the individual systems checks were completed satisfactorily prior to preparing the spacecraft for the altitude chamber runs. The following is a general resume of major changes accomplished at the launch site prior to launch:

(a) Reaction-Control System.-

- (1) Roll thrust chamber heat sinks were added.
- (2) Sham-ban flare seals were removed from the automatic system inlet and outlet connections of the thrust-chamber solenoid valves to reduce the possibility of leakage in the area of the thruster. Subsequently, all sham-ban seals that were accessible were replaced with voi-shan seals.
- (3) Nine solenoid valves were replaced during the sham-ban seal removal because of the possibility of Kel-F existing on the solenoid outlets.
- (4) The clockwise automatic roll-thruster assembly was replaced.

(b) Communications.- No outstanding problems were experienced with the communication equipment after the spacecraft arrived at Hangar "S". Readouts from the range on the C band radar beacon showed jitter and varying signal strength. These problems disappeared, as expected, when the service tower was removed.

(c) Electrical.-

- (1) Flight batteries were activated on November 8, 1961. These batteries were replaced on February 10, 1962 when one battery cell lost voltage and another had a short to case.
- (2) Both mercury cell auxiliary battery units were replaced by new units on January 13, 1962.
- (3) Inverter switching circuitry was modified to provide a non-fused circuit to the standby inverter in the manual mode.
- (4) The original 150 VA inverter malfunctioned during a hangar test and was replaced.
- (5) The suit fan toggle switch was replaced.

(6) The removable half of all fuse block holders was re-inforced.

(7) The removable telelight panel was removed, reworked, and reinstalled.

(8) The retrorocket relay panel was replaced.

(9) Due to an internal malfunction, the thrust cut-off sensor was replaced.

(10) During a hangar check, the maximum altitude sensor timed out early. This unit was replaced.

(11) The satellite clock was replaced on two separate occasions due to malfunctions.

(12) Indicator lights showing which inverter was operative were added to the instrument panel.

(d) Environmental Control System.

(1) An advanced design type of cold plates were installed under the 150 and 250 VA main inverters.

(2) Screens with .06" diameter holes were installed in the cabin fan inlet ducts.

(3) The aluminum check valves in the freon-water inverter cooling system were replaced with stainless steel valves.

(4) The high pressure O₂ reducer was replaced, due to a leak prior to the altitude chamber runs.

(5) The primary O₂ system shutoff valve stem was removed, reworked and reinstalled due to leaking O-rings.

(6) A manual blood pressure system was installed.

(7) During the first run of SEDR 77-13, the No. 1 suit fan was below specification performance. This fan was replaced.

(8) An indicator was installed on the instrument panel to give a readout of suit circuit steam vent exhaust temperature.

(9) The CO₂ absorber was replaced after the spacecraft was moved to the launching complex.

(10) The suit circuit demand regulator was replaced.

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(e) Automatic Stabilization and Control System.-

(1) During dynamic testing of the ASCS, the yaw repeater of the amplifier-calibrator would not come off its stop. The amplifier-calibrator was replaced with a new unit which included a new logic board for fuel conservation.

(2) Fuses were added in the power leads leading to the rate gyros.

(3) Eight-watt heater blankets were added to the scanners.

(f) Instrumentation.-

(1) Instrument panel and pilot observer cameras were removed, checked and reinstalled.

(2) The "E" package location near the pilot's right foot caused some discomfort and was objectionable because it presented a problem in removing the egress hatch. The package was relocated in the area of the right-hand bay.

(3) Instrumentation was added to monitor the hydrogen peroxide line temperatures on the "B" nuts of the No. 1 auto-roll thrusters and the manual-roll thrusters.

(4) The instrument panel camera was replaced due to a malfunction, after the spacecraft was moved to the launching complex.

(g) Miscellaneous.-

(1) The main and reserve flight parachutes were replaced with chutes of a more recent packing date.

(2) A personal-equipment container was fabricated and installed.

(3) Removable filters were provided for the pilot observations window.

(4) Astronaut couch was installed.

Spacecraft No. 13 was transported to Complex 14 on January 3, 1962 and was mated with the Atlas booster. All normal systems tests were successfully completed. However, due to various holds, four extra simulated flight tests and one additional launch simulation test were performed. The capsule was successfully launched on February 20, 1962.

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10.6 Telemetry, instrumentation, and onboard film.- The instrumentation system flown in MA-6 was essentially the same as in MA-5. Small changes between the two spacecrafts were required to accommodate those parameters associated with a manned mission. Other changes are as follows:

(a) Heat shield temperature in MA-6 was measured by means of a chromel-alumel thermocouple.

(b) MA-6 used only two cameras, pilot-observer and instrument-observer, deleting the earth-sky and periscope cameras.

(c) A different type of color film was used in the pilot-observer camera.

(d) In MA-6, the mixed sequence of events were superimposed on the vernier clock signal.

A complete list of the instrumented parameters is included in Table 10.6-1.

10.6.1 Flight performance and results.

Telemetry.- Both telemetry transmitters exhibited a center-frequency shift and signal strength rise when the escape tower was jettisoned. This effect, resulting from a change in antenna VSWR was anticipated and will be taken into account when setting the center frequencies for the transmitters on future spacecrafts. The change in VSWR is generally insignificant enough that the transmitters can be adjusted so that the center frequencies will be within specification for both tower-on and tower-off conditions. The signal strengths and deviation from center frequency as read by AMR when the spacecraft passed over the Cape are shown in Table 10.6.1-1.

Data quality.- The quality of the data reduced from the on-board tape was very good. Scatter and noise caused by tape speed variations was insignificant and easily compensable on the continuous channels. The only problem area occurred during the time of exit maximum dynamic pressure when vibrational affects on the recorder caused almost complete loss of data; however, the real-time data during the same period covers the lapse.

A comparison of the hand controller (stick position) data as instrumented on continuous and commutated channels shows the definite advantage of instrumenting this parameter by means of a continuous channel. About 50 per cent of the stick position data are lost on the commutated channel and the commutated data which are present are difficult to interpret.

Photographic - The instrument-observer camera malfunctioned prior to the start of the flight, during the 60-second test at T-55 minutes in the count. The film slipped out of the film gate with the camera continuing to run, giving an indication it was operating properly.

The results obtained from the pilot-observer camera were generally good. The use of the Ektachrome ER color film is an improvement over that which has been used in previous capsules.

On-board timing - The vernier-clock channel malfunctioned throughout the entire flight. Each time the pilot-observer camera operated a spurious pulse was produced in the vernier clock signal; at times, when the camera operated at high speed, the signal was rendered almost useless. The satellite clock is presently being redesigned to include a 1-PPS output which can be used to directly modulate the voltage-controlled oscillator. The new design will utilize, as a trigger, the same 28v dc signal which steps the clock digital counters. This will be a great improvement in signal-to-noise ratio and should eliminate the problem.

From the instrumentation standpoint, the most serious problem resulting from the MA-6 mission was in the respiration rate and depth channel. The principle of operation of the circuit is a thermistor sensor which is heated by a dc voltage; when the subject breathes on the sensor, it cools and changes resistance, producing a voltage change on the output of a direct-coupled transistor amplifier. The basic problem is that the thermistor temperature is subject to changes in ambient temperature and flow. Because of changes in temperature and flow, the base line of the respiratory signal varied from a value of 10 per cent set during the suiting procedure up to a maximum of 85 per cent at lift-off. After lift-off, the base line fell steadily until it reached a low of 10 per cent at 02:08:00; then it began to rise again and had attained a 40 per cent level at loss of signal. The sensitivity of the signal degraded in direct proportion to the base line shift since the sensitivity decreases as the base line increases. The sensitivity problem is further complicated by the fact that the position of the sensor is not fixed to the position of the pilot's head. In the MA-6 mission, much of the data were lost because the pilot was not breathing directly on the sensor. Both the subcarrier oscillators encoding the respiration data performed per specification and did not contribute to the above effects.

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10.6-1.- COMMUTATOR POINT ASSIGNMENT FOR MA-6

COMM. HF	COMM. LF	PARAMETER	RANGE
1	1	3-volt reference	3 v
2	2	Zero ground reference	0 v
3	3	AC amplifier power supply monitor	7 v ac
4	4	Body temperature	95° - 107° F
5	5	Command receiver, all channels signal	On-Off
6	6	Oxygen partial pressure	0 - 800 mm Hg
7	7	"A" command receiver signal strength	0 - 80 μ volts
8	8	"B" command receiver signal strength	0 - 80 μ volts
9	9	Suit pressure	0 - 15 psia
10	10	Oxygen supply pressure primary	0 - 7500 psig
11	11	Cabin air temperature	40° - 200° F
12	12	Suit inlet air temperature	40° - 100° F
13	13	Oxygen supply pressure secondary	0 - 7500 psig
14	14	Y-axis accelerometer (13, 43 and 73)	$\pm 0.5g, \pm 4g$
15	15	X-axis accelerometer (14, 44 and 74)	$\pm 0.5g, \pm 4g$
16	16	Z-axis accelerometer (15, 45 and 75)	$\pm 30g$
17	17	Pitch attitude ASCS calibrator	-140° to + 180° F
18	18	Roll attitude ASCS calibrator	-130° to + 200° F
19	19	Yaw attitude ASCS calibrator	-70° to + 250° F
20	20	Roll CW manual - fuel line temperature	0 - 250° F
21	21	Roll CCW manual - fuel line temperature	0 - 250° F
22	22	Lo roll CW auto - fuel line temperature	0 - 250° F
23	23	Lo roll CCW auto - fuel line temperature	0 - 250° F
24	24	250 va inverter temperature	40° - 300° F
25	25	Static pressure	0 - 15 psia
26	26	Stick position roll	$\pm 13°$
27	27	Stick position pitch	$\pm 13°$
28	28	Stick position yaw	$\pm 13°$
29	29	Elapsed time (10 seconds)	
30	30	"A" command receiver signal strength	0 - 80 μ volts
31	31	"B" command receiver signal strength	0 - 80 μ volts
32	32	Elapsed time (1 minute)	
33	33	Elapsed time (10 minutes)	
34	34	Elapsed time (1 hour)	
35	35	Elapsed time (10 hours)	
36	36	150 va inverter temperature	40° - 300° F
37	37	Time of retrograde (10 seconds)	
		Time of retrograde (1 minute)	
		Time of retrograde (10 minutes)	
		Time of retrograde (1 hour)	
		Time of retrograde (10 hours)	

10.6-1.- COMMUTATOR POINT ASSIGNMENT FOR MA-6 (continued)

COMM. HF	COMM. LF	PARAMETER	RANGE	POS
38	38	Horizon scanner pitch ignore	On-Off	1
39	39	Reaction control supply pressure (auto)	600 - 2200 psig	2
40	40	Reaction control supply pressure (manual)	600 - 2200 psig	3
41	41	AC voltage monitor (fans bus)	95 - 120v ac	4
42	42	DC current monitor	0 - 50 amps	5
43	43	Y-axis accelerometer		6
44	44	X-axis accelerometer		7
45	45	Z-axis accelerometer		8
46	46	Tower release	On-Off	9
47	47	Capsule separation	On-Off	10
48	48	Retro attitude command	On-Off	11
49	49	"A" command receiver signal strength		12
50	50	"B" Command receiver signal strength		13
51	51	Retrofire timing signal	On-Off	14
52	52	Impact bag deploy	On-Off	15
53	53	Integrating accelerometer signal	0 - 600 ft/sec	16
54	54	Retro assembly jettison	On-Off	17
55	55	Drogue chute deploy	On-Off	18
56	56	Antenna fairing release	On-Off	19
57	57	Main chute deploy	On-Off	20
58	58	Main Chute Jettison	On-Off	21
59	59	Reserve chute deploy	On-Off	22
60	60	Pilot abort	On-Off	23
61	61	Mayday	On-Off	24
62	62	Tower escape rockets	On-Off	25
63	63	Standby inverter "On"	On-Off	26
64	64	ASCS slaving signal	On-Off	27
65	65	Calibrate Z/Cal, R/Cal (also 25%, 50%, 75% Ref.)	On-Off	28
66	66	High pressure reaction jet solenoids (+ pitch)	On-Off	29
67	67	High pressure reaction jet solenoids (- pitch)	On-Off	30
68	68	18-volt ISOL voltage	16 - 22v dc	31
69	69	18-volt standby voltage	16 - 22v dc	32
70	70	Oxygen emergency rate mode	On-Off	33
		High pressure reaction jet solenoids (+ roll)	On-Off	34
		High pressure reaction jet solenoids (- roll)	On-Off	35

(10.6.1.- COMMUTATOR POINT ASSIGNMENT FOR MA-6 (continued)

COMM. HF	COMM. LF	PARAMETER	RANGE
71	71	"A" command receiver signal strength	0.40 - 0.50
	71	"B" command receiver signal strength	0.20 - 0.30
72	72	- Periscope retract signal	On-Off
73	73	Y-axis accelerometer	1.3
74	74	Y-axis accelerometer	1.7
75	75	Z-axis accelerometer	2.3
76	76	Heat shield temperature (thermocouple)	0° - 2500° F
77	77	ASCS bus voltage	95 - 125v ac
78	78	High pressure reaction jet solenoids (- yaw)	On-Off
79	79	High pressure reaction jet solenoids (+ yaw)	On-Off
80	80	Retrorocket temperature	0° - 150° F
81	81	HF telemetry transmitter temperature	40° - 300° F
	81	LF telemetry transmitter temperature	40° - 300° F
82	82	Cabin pressure	0 - 15 psia
83	83	DC voltage monitor	18 - 28v dc
84	84	Coolant pressure	230 - 485 psig
85	85	Horizon scanner roll ignore	On-Off
86	86	Horizon scanner output monitor roll	+ 35°
87	87	*.05g relay actuation	On-Off
88	88	Horizon scanner output monitor pitch	+ 35°
89	89	Synchronize pulse	
90	90	Synchronize pulse	

ON-BOARD TAPE RECORDER TRACK ASSIGNMENTS	TRACK
Open	1
High frequency telemetry multiplex	2
Voice	3
PIM high frequency	4
PIM low frequency	5
Low frequency telemetry multiplex	6
Open	7

10.6-1.- COMMUTATOR POINT ASSIGNMENT FOR MA-6 (continued)

HIGH FREQ. SYSTEM	CONTINUOUS CHANNELS	RANGE	
0.40	Roll rate and low roll thruster (mixed)	$\pm 10^\circ/\text{sec.}$	17
0.56	Vernier clock and sequence of events (mixed)	1-FPS	17
0.73	DC volts	18 - 28v dc	17
1.3	R.R. and D		17
1.7	EKG (left side, right side)		17
2.3	EKG and blood pressure (upper chest, lower chest)		17
3.0	Reference		17
3.9	Stick position, roll	$\pm 13^\circ$	17
10.5	High frequency commutator (PAM)		17

LOW FREQ. SYSTEM	CONTINUOUS CHANNELS	RANGE	
0.40	Pitch rate and low pitch thrusters (mixed)	$\pm 10^\circ/\text{sec.}$	18
0.56	Yaw rate and low rate thrusters (mixed)	$\pm 10^\circ/\text{sec.}$	18
0.73	D.C. Current	0 - 50 amp	18
1.3	R.R. and D		18
1.7	EKG (left side, right side)		18
2.3	EKG and blood pressure (upper chest, lower chest)		18
3.9	Stick position pitch	$\pm 13^\circ$	18
5.4	Stick position yaw	$\pm 13^\circ$	18
10.5	Low frequency commutator (PAM)		18

ON-BOARD TAPE RECORDER TRACK ASSIGNMENTS

TRACK	INFORMATION
1	Open
2	High frequency telemetry multiplex
3	Voice
4	PIM high frequency
5	PIM low frequency
6	Low frequency telemetry multiplex
7	Open

10.6.1-1 TELEMETRY SIGNAL STRENGTH AND DEVIATION FROM CENTER
FREQUENCY AS RECORDED BY AMR

	S/S in DBM		Deviation from* Center Freq., KC	
	Low	High	Low	High
Lift-off	-30	-30	+13.9	-45.2
Tower release	-52	-52	- 1.0	-29.0
Orbit 1	-35	-52	- 5.0	-21.5
Orbit 2	-30	-45	- 3.0	-20.9
Orbit 3	-60.5	-55.5	0.	-18.0

*Specification deviation: +26 KC (High Link)

+22 KC (Low Link)

Downrange telemetry coverage used for engineering evaluation of the mission was satisfactory and film quality was average. Seven motion picture films and numerous still photographs were available for review. Two motion picture films presented a portion of the prelaunch activities, including astronaut preparation at Hangar B, insertion of the astronaut into the spacecraft, closing of the hatch and securing for launch, and portions of the operational activity at the Mercury Control Center during the mission. Coverage and quality of these two films were good. Four motion picture films presented portions of the recovery operation including aerial and shipboard coverage of spacecraft retrieval from the water, removal of the hatch, astronaut egress, transfer from the recovery ship, and the physical examination aboard the carrier. One film included views of the astronaut at Grand Turk Island and the spacecraft being loaded aboard the aircraft for transport to the Cape. Still photographs included views similar to those documented by motion picture with the exception of hatch removal prior to astronaut egress onboard the recovery ship. Numerous engineering still photographs were available showing close-up views of the spacecraft after recovery and during postflight inspection at Hangar B.

10.7

AMR optical coverage. - AMR optical coverage including quantity of instrumentation committed and data obtained during launch phase is in table 10.7-1. AMR optical tracking from lift-off or first acquisition to limits of visibility is shown in figure 10.7-1.

Metric film. - Metric films were reduced and results were tabulated by AMR, but these data were not required for evaluation by MSC since the powered flight phase was normal.

Engineering sequential film. - Engineering sequential coverage at AMR Station 1 during launch phase was satisfactory. Thirteen films were reviewed, including 16mm and 35mm films from three fixed cameras and ten tracking cameras. The quality of fixed camera coverage was excellent and indicated normal umbilical ejection, periscope retraction, booster ignition, and lift-off. The quality of tracking camera coverage was good with the exception of some poor quality coverage of the early portion of powered flight due to ground haze conditions at lift-off. All tracking cameras indicated normal booster staging and tower separation.

Documentary film. - Documentary coverage used for engineering evaluation of the mission was satisfactory and film quality was average. Seven motion picture films and numerous still photographs were available for review. Two motion picture films presented a portion of the prelaunch activities, including astronaut preparation at Hangar S, insertion of the astronaut into the spacecraft, closing of the hatch and securing for launch, and portions of the operational activity at the Mercury Control Center during the mission. Coverage and quality of these two films were good. Four motion picture films presented portions of the recovery operation including aerial and shipboard coverage of spacecraft retrieval from the water, removal of the hatch, astronaut egress, transfer from the recovery ship, and the physical examination aboard the carrier. One film included views of the astronaut at Grand Turk Island and the spacecraft being loaded aboard the aircraft for transport to the Cape. Still picture coverage included views similar to those documented by motion picture with the exception of hatch removal prior to astronaut egress onboard the recovery ship. Numerous engineering still photographs were available showing close-up views of the spacecraft after recovery and during postflight inspection at Hangar S.

TABLE 10.7-1.- AMR OPTICAL COVERAGE OF LAUNCH AND REENTRY PHASE

8.01

Film Type	Station	No. of Items Committed	No. of Items Obtained	Lost Items	Reason for Loss
Metric	1	15	15	0	N/A
Engineering Sequential	1	47	46	*1	No reentry data
Engineering Sequential	3	1	0	*1	No reentry data
Engineering Sequential	5	1	0	*1	No reentry data
Documentary	1	88	88	0	N/A
*Planned for reentry coverage.					

- 10.8 Flight safety reviews. - Two series of meetings were held by the MA-6 Flight Safety Review Board because of the launch postponements.

First series of reviews. - The following meetings were conducted in anticipation of launch on January 24 and January 27, 1962. The launch was rescheduled from January 24 to January 27 when an oxygen leak in the spacecraft Environmental Control System (ECS) was discovered on January 20. The countdown on January 27 was conducted until 20 minutes before launch at which time the weather caused postponement of the launch attempt.

The first spacecraft review meeting was held at 1:00 p.m. on January 18, 1962. The spacecraft history at AMR and the present status of all the spacecraft systems were reviewed and the spacecraft approved as ready for flight. A second review meeting, scheduled after the oxygen leak had been repaired, was held at 11:15 a.m. on January 24, 1962. During this meeting the status of the spacecraft systems was discussed and all systems, including the ECS, were again approved as ready for flight.

The first Booster Review meeting was held at 4:00 p.m. on January 19, 1962. All booster and supporting systems were approved as ready for flight.

The Mission Review meeting was held at 1:00 p.m. on January 25, 1962, and all elements for the flight were found to be in readiness.

When the Flight Safety Board convened at 9:30 a.m. on January 26, 1962, it was reported that the booster was not in a flight status due to broken wires and damaged pins in separation plug no. 2012. This plug carries booster engine autopilot commands, rough combustion cutoff circuitry, and engine indications and is separated at booster separation (staging). The plug was repaired and when the Flight Safety Board met again at 1:00 p.m. on January 26, the booster was ready to be committed to flight.

Weather caused the January 27, 1962, launch attempt to be postponed.

Second series of reviews. - On January 30, 1962, fuel was discovered in the insulation between the structural bulkhead and the insulation bulkhead separating the booster fuel and oxidizer tanks. Fuel had leaked into this area through a flange bolt. The decision was made to remove the insulation and insulation bulkhead, and this work period caused the launch to be rescheduled for February 13, 1962. Weather forced 3 more postponements to February 14, 15, and 20.

No separate spacecraft or booster review meetings were held during this period.

The second Mission Review meeting was held at 3:00 p.m. on February 12, 1962. Satisfactory removal of the booster insulation had been made and all systems were found ready for flight.

Booster status meetings were held on February 13 and 19, and the Flight Safety Board recommended that the mission proceed, as everything was in readiness.

(c) Obtain the astronaut's opinions on the operational suitability of the spacecraft and supporting systems for manned space flight.

Systems priorities--

- | <u>Priority</u> | |
|-----------------|--|
| | (a) Communications system |
| Primary | (1) Command receiver no. 1 |
| Primary | (2) Command receiver no. 2 |
| Primary | (3) Low frequency telemetry (225.7 mc) |
| Primary | (4) High frequency telemetry (229.7 mc) |
| Primary | (5) UHF and HF voice |
| Primary | (6) C-band beacon |
| Primary | (7) S-band beacon |
| Primary | (8) SARAH beacon |
| Primary | (9) SUPERBARKAR beacon |
| Primary | (10) SEASAVE beacon |
| Primary | (b) Automatic Stabilization and Control System |
| Primary | (c) Rate Stabilization Control System |
| Primary | (d) Reaction Control System |

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- 10.9 Test objectives.-
- (a) Evaluate the performance of a man-spacecraft system in a three-orbit mission.
 - (b) Evaluate the effects of space flight on the astronaut.
 - (c) Obtain the astronaut's opinions on the operational suitability of the spacecraft and supporting systems for manned space flight.

Systems priorities.-

	<u>Priority</u>
(a) Communications system	
(1) Command receiver no. 1	Primary
(2) Command receiver no. 2	Primary
(3) Low frequency telemetry (225.7 mc)	Primary
(4) High frequency telemetry (259.7 mc)	Primary
(5) UHF and HF voice	Primary
(6) C-band beacon	Primary
(7) S-band beacon	Primary
(8) SARAH beacon	Primary
(9) SUPERSARAH beacon	Primary
(10) SEASAVE beacon	Primary
(b) Automatic Stabilization and Control System	Primary
(c) Rate Stabilization Control System	Primary
(d) Reaction Control System	Primary

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acknowledgment - The Flight Evaluation Team for the MA-6 flight, and those who composed as

(e) Environmental Control System Primary

(f) Electrical Power System Primary

(g) Explosive devices Primary

(h) Cabin equipment Primary

(1) Navigation instruments Primary

(2) ECS indicators Primary

(3) Electrical system indicators Primary

(4) Sequential and warning lights Primary

(5) ASCS indicators Primary

(6) Satellite clock Primary

(i) Rocket system Primary

(j) Landing and recovery system Primary

(k) Instrumentation system Primary

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Acknowledgement. - The Flight Evaluation Team for the MA-6 flight, and from whose analysis this report is based, was composed as follows:

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Primary (1) Navigation Instruments

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Primary (4) Sequential and Lights

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5.5 ELECTRICAL AND SEQUENTIAL

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5.6 VIBRATIONS

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6.0 LAUNCH VEHICLE BOOSTER PERFORMANCE

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10.3 WEATHER CONDITIONS

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10.1 SPACECRAFT POSTFLIGHT INSPECTION

A. J. Saecker
H. H. Laughlin
R. B. Gendle
J. Janssens
E. R. Zinn
H. K. Logan
C. G. Prof...

- 11.1 Introduction. - The areas of major importance in the MA-6 mission are discussed briefly in this section. Problems and associated actions, recommendations, and conclusions are listed. Appropriate sections of the report are referenced for detailed discussion.
- 11.2 Problems and items of interest. -
- 11.2.1 Spacecraft. -
- (a) RCS - The hydrogen peroxide distribution (dutch weave) screens downstream of the metering orifices on the 1-pound and 6-pounds thrusters were found to be deteriorated excessively after the flight. Fragments from these screens are suspected of having caused the 1-pound yaw thrusters to malfunction on this mission. Action: NASA and contractor teams are vigorously pursuing a program to provide a suitable replacement before the next mission. (Section 5.1)
- (b) ASCS - Differences in spacecraft attitude as observed by astronaut and readout on instruments have all been investigated and found to have been caused by the normal action of the automatic gyro precession and/or gyro slaving while the capsule was maneuvered manually by the astronaut. Action: Studies are underway to provide astronaut control (on-off) of these automatic functions on subsequent spacecraft. (Section 5.1)
- (c) ASCS - Differences between desired spacecraft attitudes and achieved attitudes after gyro caging and uncaging while on ASCS as reported by the astronaut have been investigated and found to have resulted from the spacecraft attitude that existed at the time of uncaging. Action: Astronaut training will be modified to include proper training sessions to avoid this trouble. (Section 5.1)
- (d) Control System - During reentry the spacecraft experienced unsatisfactory oscillatory motions. Employment of the auxiliary damping mode apparently gave only temporary relief. However, analysis of the data indicates that manual control was not always applied to damp the motion. Also, the data show that the auxiliary damping mode was effective until the fuel was probably depleted. Action: Study the need for a change in flight plan and in the ground rules to insure that sufficient control fuel will be available during entry so that the auxiliary damping mode or RCS mode can be used to control the oscillations. (Section 5.1)
- (e) Instrumentation - The heat-shield-deployed signal during orbit apparently was caused by a defective switch. Action: The switches are to be inspected more closely, rigged farther from the deploy position, and wired in series with the T/M transducer and telelight on subsequent capsule. (Section 10.6)

(f) ECS - An unexpected decay of the secondary oxygen supply pressure and an expected decrease in main oxygen supply use rate during orbital flight and a change in the "constant bleed" orifice capacity between pre-flight and post-flight checks are unexplained at this time. Action: Post-flight checks of the spacecraft ECS will continue. (Section 5.2)

(g) ECS - Post-flight tests disclosed that stainless steel check valves in the cold-plate water circuit and in the Freon suit-circuit were deficient. Action: Contractor told to remedy this recurring problem. (Section 5.2)

(h) Command system - The command signals were received onboard the spacecraft at about 6 db less than the signals recorded during the MA-4 and MA-5 missions. Action: An investigation is underway to determine the cause of the decrease in signal strength. (Section 8.3.4)

(i) Command system - The all-function-events-channel was triggered five times during the time the spacecraft was passing through the reentry blackout; however, no events were initiated onboard the spacecraft. Action: An investigation is underway to determine the cause and possible significance of these apparent spurious tones. (Section 8.3.4)

(j) Instrumentation - The instrument-panel camera failed before lift-off. Action: Contractor told to take corrective action. (Section 10.6)

(k) Instrumentation - Procedures are now to pressurize spacecraft oxygen bottles to approximately 8000 psig to insure full supply of oxygen for the mission. Presently used pressure transducers can measure only to 7500 psig. Action: Higher-range transducers have been requested for subsequent spacecraft. (Section 10.6)

(l) Structure - Close examination of the spacecraft heat shield and shingles has not disclosed any significant effects from reentering without jettisoning the retrorocket package. Action: None required

(m) Sequential system - The short but unexpected delay, at spacecraft-booster separation, of initiation of rate damping, periscope extension, and cap-sep telelight illumination resulted from proper operation of the sequence system. However, the change that was made to the system to accomplish this was incorporated in spacecraft 13 without full understanding of all parties concerned. Action: The sequence system will be changed to the earlier, satisfactory, configuration for subsequent capsules and

the contractor will review changes incorporated in other spacecraft for similar undesirable side-effects. (Section 5.1)

(n) Sequential system - The drogue parachute was deployed at an altitude considerably in excess of the planned altitude, probably greater than 27,000 feet compared with a nominal 21,000 feet. Action: Continue post-flight tests on spacecraft electrical and pressure sensing systems. (Section 5.4)

11.2.1 Range - In spite of good radar data during reentry, most of the impact-point predictions missed the actual landing point by large margins. Action: The reason for failure to predict the landing point with accustomed accuracy is being investigated. (Section 8.3.1)

11.3 Conclusions.-

(a) All primary objectives of the MA-6 mission were accomplished.

(b) No deleterious effects of spaceflight on the astronaut's performance or physical condition were evident during or after the mission.

(c) Acceptable launch vehicle performance and spacecraft orbital insertion were achieved.

(d) The spacecraft and its systems are capable of accomplishing the Mercury mission although problem areas still exist.

(e) Astronaut training was generally satisfactory.

(f) Recovery procedures utilized for this mission were satisfactory.

(g) Network performance and support was excellent.

(h) Flight control operational procedures were satisfactory and the value of flight control simulations was demonstrated.

11.4 Recommendations.-

(a) Retrofire and reentry should be performed using the automatic system to conserve fuel.

(b) Air-to-ground communication procedures should be reviewed in an effort to provide better utilization of the astronaut's time in flight.

(c) Provide the astronaut with a private onboard recording channel, that is not broadcast, to allow voice recording of unusual phenomena or other observations not suitable for unrestricted public dissemination.

(d) Initiate further development or replacement of the respiration sensor.

(e) Continue to monitor the astronaut's ECG, blood pressure, respiration rate, and body temperature in future missions.

(f) Provide for appropriate fluid intake by the astronaut during countdown and flight.

(g) Urge the astronaut to keep the bioplug connected until after landing and, if feasible, until instrumentation is cut off.

(h) Provide for additional training in the use of the pilot's personal equipment in the spacecraft.

(i) Provide reentry dynamic simulation on the Cape Procedures Trainer.

(j) Include automatic pitch-program precession on the Attitude Control System Demonstrator.

(k) Improve the simulation of external reference systems, particularly in yaw.

(l) Recovery procedures utilized for this mission were satisfactory.

(m) Network performance and support was excellent.

(n) Flight control operational procedures were satisfactory and the value of flight control simulations was demonstrated.

(o) Retrospective and reentry should be performed using the automatic system to conserve fuel.

(p) Air-to-ground communication procedures should be reviewed in an effort to provide better utilization of the astronaut's time in flight.

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TECHNICAL RESULTS OF THE FIRST/
MANNED ORBITAL FLIGHT
FROM THE UNITED STATES/
PART I - MISSION RESULTS

Prepared by
Mercury Project Office
Edited by J. H. Boynton

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Acknowledgement is presented at the conclusion of this report to the many systems specialists who authored and assisted in updating specific portions of the text.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TECHNICAL MEMORANDUM X -

MERCURY-ATLAS MISSION 6 (MA-6 SPACECRAFT 13)
RESULTS, DESCRIPTION AND PERFORMANCE ANALYSIS

Edited by John H. Boynton

SUMMARY

The Mercury-Atlas Mission 6 was the first United States manned orbital flight, and all prescribed mission objectives were successfully accomplished. A complete description of the mission, including a listing of its preflight objectives and a postlaunch evaluation, is presented.

A comparison of all planned and actual sequence data indicates that mission parameters coincide with expected values. The spacecraft, launch vehicle, and Mercury Network functioned satisfactorily during the mission. Early in the flight, however, the onboard telemetry transmitted an ominous signal to the ground that the heat shield was not firmly attached to the spacecraft. A subsequent analysis resulted in a recommendation to Astronaut Glenn that the retropackage be retained into reentry in order to ensure correct placement of the heat shield. A postflight investigation revealed a faulty limit switch as the source of an incorrect

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telemetry signal, and the heat shield, in fact, was not improperly .
deployed during the orbital flight. During the second orbital pass,
failure of the one-pound yaw thrusters, caused repeated loss of
automatic orbital stabilization, requiring the astronaut to manually
control the Spacecraft for the remainder of the mission. Despite
these and other minor malfunctions, the mission was completed
successfully, and recovery was effected in the prescribed area by
the destroyer Noa within twenty minutes from landing.

The astronaut's performance during all mission phases was
highly satisfactory, and no deleterious effects of weightlessness
were noted. Astronaut Glenn was found to be in excellent physiological
and psychological health during the postflight examination.

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INTRODUCTION

The first manned orbital flight in conjunction with Project Mercury was successfully performed on February 20, 1962, from the Cape Canaveral Missile Test Center. Astronaut John H. Glenn, Jr., shown in Figures 1 through 4, was the assigned pilot for this Mercury-Atlas (MA-6) Mission. This was the third orbital flight of a Mercury specification spacecraft, and it marked the sixth of a series utilizing Atlas launch vehicles.

The MA-6 mission was planned for three orbital passes and was the culmination of a program to develop the Mercury spacecraft for manned orbital flight. The objectives of the flight were to evaluate the performance of the manned spacecraft system in a three-pass mission, to evaluate the effects of space flight on the astronaut, and to obtain the astronaut's evaluation of the operational suitability of the spacecraft and supporting systems for manned orbital missions.

All data telemetered and recorded during the flight has been thoroughly analyzed by specialists in their fields, and this report presents these results and their analyses. Brief descriptions of the mission, the spacecraft, and the launch vehicle precede the performance analysis and supporting data. All significant events of the MA-6 mission, beginning with delivery of the spacecraft to the launch site through recovery and post flight examinations, are documented.

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Although the graphical information presented herein sufficiently supports the text, the reader is referred to THX_____ (reference 1) for a complete presentation, without analysis, of all MA-6 time history data.

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MISSION DESCRIPTION

Mission Objectives

The mission objectives and systems priorities, as specified in the Project Mercury Mission Directive for MA-6/13, are listed below for reference.

Test Objectives

1. Evaluate the performance of a man-spacecraft system in a three-pass mission.
2. Evaluate the effects of spaceflight on the astronaut.
3. Obtain the astronaut's opinions of the operational suitability of the spacecraft and supporting systems for manned spaceflights.

Systems Priorities

(a) Communications system	Priority
(1) Command receiver no. 1	Primary
(2) Command receiver no. 2	Primary
(3) Low frequency telemetry (225.7 mc)	Primary
(4) High frequency telemetry (259.7 mc)	Primary
(5) UHF and HF voice	Primary
(6) C-band beacon	Primary

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(7) S-band beacon	Primary
(8) SARAH beacon	Primary
(9) SUPERSARAH beacon	Primary
(10) SEASAVE beacon	Primary
(b) Automatic Stabilization and Control System	Primary
(c) Rate Stabilization Control System	Primary
(d) Reaction Control System	Primary
(e) Environmental Control System	Primary
(f) Electrical Power System	Primary
(g) Explosive devices	Primary
(h) Cabin equipment	
(1) Navigation instruments	Primary
(2) ECS indicators	Primary
(3) Electrical system indicators	Primary
(4) Sequential and warning lights	Primary
(5) ASCS indicators	Primary
(6) Satellite clock	Primary
(i) Rocket system	Primary
(j) Landing and recovery system	Primary
(k) Instrumentation system	Primary

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MISSION EVALUATION

The MA-6 mission, with Astronaut John Glenn as the pilot, experienced unscheduled prelaunch holds totaling 2 hours and 17 minutes. This was the result of difficulties with the General Electric guidance rate beacon and a spacecraft-hatch bolt, in addition to allowances for topping fuel, loxing the launch vehicle, and verifying the Bermuda computer after a ground power failure. The vehicle lifted off at approximately 0947 e.s.t. on February 20, 1962; 3 hours and 42 minutes after the astronaut entered the spacecraft.

All Atlas flight parameters were normal during launch. Vibration amplitudes and frequencies were acceptable and comparable to those experienced during the MA-5 launch. Spacecraft orbital insertion conditions were excellent. Deviations from nominal values of inertial flightpath angle and velocity were $-.05$ degrees and -7 ft/sec, respectively, with a resultant capability of nearly 100 orbital passes. General Electric-Burroughs and AZUSA guidance data both indicated a "GO" condition after sustainer engine cut off. The perigee and apogee of the orbit differed from the nominal values of 87.0 and 144.4 nautical miles by 0.1 nautical miles and 3.5 nautical miles, respectively.

Spacecraft separation, rate damping, and turnaround were accomplished satisfactorily. With the exception of steadily rising temperatures on both inverters, all spacecraft systems performed satisfactorily during the first pass.

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The astronaut observed the launch vehicle tankage in its slightly lower orbit for some time, checked out the spacecraft control systems, performed planned tasks and made scientific observations, including a report of small luminous-appearing particles around the spacecraft at sunrise.

At approximately the beginning of the second orbital period, the astronaut reported that the spacecraft was not maintaining acceptable attitudes in the orbit mode of control in right and later in left yaw. This was because of a thrust loss from the low thrusters. The astronaut elected to control the spacecraft manually to conserve fuel, and most of the remainder of the mission was flown in a manual control mode. Necessary attention to control of the spacecraft precluded accomplishment of some flight-plan items.

However, the astronaut accomplished the major planned tasks and confirmed the major weather phenomena were visible on the moonlit dark side of the earth. He controlled the spacecraft attitudes by visual reference to the horizon and stars on the dark side of the earth, and spacecraft maneuvers were performed manually, including 180° yaw maneuvers.

During the second and third passes, an indication from telemetry that the spacecraft heat shield might be unlocked caused some concern. A recommendation was made that the empty retropack be retained on the spacecraft during reentry at the end of the third orbital pass. The intent was to hold the heat shield in place until sufficient

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aerodynamic pressure was built up, in case it was unlatched. The retropack had no detectable effect on the reentry. It was later disclosed that the heat shield had not been prematurely released.

Spacecraft attitudes during the retrofire maneuver were controlled by both the automatic control system and the astronaut using manual control. Spacecraft oscillations diverged during reentry and were not satisfactorily controlled until the drogue parachute stabilized the spacecraft. The drogue parachute deployed at about 27,000 feet, rather than the planned 21,000 feet. Landing (at 04:55:16) occurred approximately 40 nautical miles uprange of the planned landing point. The spacecraft, with the astronaut inside, was recovered some 17 minutes after landing by the destroyer Noa. The astronaut was found to be in excellent physiological condition.

Network operations, including telemetry reception, radar tracking, communications, command control and computing were excellent, which permitted effective flight control during the mission.

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SPACE VEHICLE DESCRIPTION

A photograph of the space vehicle lift-off configuration, consisting of the spacecraft and the launch vehicle, is shown in figure 5.

Spacecraft - Spacecraft No. 13, shown in figure 6 was utilized for the MA-6 manned orbital mission. The spacecraft axis system is shown in figure 7. The primary differences between spacecraft no. 13 and spacecraft no. 9 (MA-5 mission) are listed below:

1. An astronaut's couch was installed.
2. A personal-equipment container was installed.
3. Filters were provided for the astronaut's window.
4. An indicator was added to the instrument panel which displayed the temperature of the suit circuit steam vent.
5. The suit circuit incorporated a constant-bleed orifice (750 cc/min).
6. The suit shutoff valve spring force decreased to approximately 25 lbs., compared to about 40 lbs. for spacecraft no. 9.
7. The cabin-fan inlet duct incorporated improved screens.
8. The latching relay to lock in the number 2 suit fan was omitted.
9. The suit-inlet snorkel door was located on the conical after-body.
10. Cooling plates of the new design were installed under the 150 VA and 250 VA main inverters, and the stainless steel check

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valves were installed in the coolant line in lieu of aluminum valves.

11. The Manual Proportional control system linkage had shear pins added.

12. Improved heat-condition paths and heat sinks were installed near the thrusters for temperature control of the roll thruster fuel lines.

13. Indicating lights were added to the instrument panel to show which inverters were operative.

14. Direct manual switching without fuses to the inverters was incorporated.

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15. The maximum altitude sensor was provided a separate battery.
16. One-ohm fuses were installed in all squib circuits.
17. An integrating accelerometer was installed.
18. A Super SARAH beacon was incorporated in lieu of an Ultra SARAH.
19. A reserve chute was installed.
20. A switch was installed to allow manual override of heat-shield deployment.
21. The escape tower legs were of heavier construction.
22. A manually actuated blood pressure measuring system was incorporated.

The weight and balance parameters for spacecraft no. 13 are shown in the following table:

Parameter	Mission Phase				
	Launch	Orbit	Normal Reentry Configuration	Normal Reentry Configuration Plus Retropack (Rockets Fired)	Flotation
Weight, pounds	4265.26	2986.78	2698.98	2815.95	2421.79
Center of Gravity station, inches	Z 167.96	121.18	124.62	123.02	119.74
	X .31	-.04	-.07	-.06	-.33
	Y -.08	.07	.01	.01	.16
Moments of Inertia, slugs-ft ²	I _z 384.0	281.6	271.0	275.1	258.1
	I _x 7761.1	621.6	544.6	581.8	353.4
	I _y 7767.5	629.3	552.2	589.4	359.5

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Launch Vehicle. - The MA-6 launch vehicle, Atlas No. 109-D, was modified for the mission as on previous Mercury-Atlas flights. A sketch showing the general configuration is shown in figure 8. It differed from the MA-5 Mercury-Atlas booster (93-d) in one major respect. The insulation and its retaining bulkhead between the lox and fuel tank dome was removed prior to launch when it was discovered that fuel had leaked into this insulation. The original requirement for this insulation and retainer had been deleted earlier in the Atlas development program as being non-essential, and this insulation is not retained in the operational ICBM version.

The following minor modifications were incorporated on MA-6 and are planned for future Mercury-Atlas flights:

1. The gyro canister was modified to include specially selected transistors of the original design type that had good thermal characteristics. This change decreases the possibility of thermal run-away in the gyro torquer and signal amplifier.
2. The booster lox-tank pressure parameter for the Abort Sensing and Implementation System (ASIS) was changed from 21.5 ± 1.0 psi to 19.5 ± 1.0 psi to protect against an inadvertent abort due to lox - tank-ullage pressure transients which occur at lift-off.

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EVENTS, TRAJECTORY, AND GUIDANCE

Sequence of Events

The times at which the major events occurred are given in table I.

Trajectory

The ground track of the flight is shown in figure 9, and the altitude-longitude profile is shown in figure 10.

The launch trajectory data, shown in figure 11, are based on the real time output of the Range Safety Impact Predictor Computer (which used AZUSA MK II and Cape FPS-16 radars) and the General Electric-Burroughs guidance computer. The data from those tracking facilities were used during the time periods listed below.

<u>Facility</u>	<u>Time, Min:Sec</u>
Cape Canaveral FPS-16	0 to 00:45
AZUSA MK II	00:45 to 01:03
GE-Burroughs	01:03 to 05:02

The parameters shown for the "planned" launch trajectory in table I were computed using the 1959 ARDC model atmosphere to maintain consistency with other published preflight trajectory documents. The density of the Cape Canaveral atmosphere is approximately 10 percent higher than that of 1959 ARDC atmosphere in the region of maximum dynamic pressure (about 37,000 feet altitude). As a result, the maximum dynamic pressure expected would be about 10 percent higher than that

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shown as "planned". For this flight, the maximum dynamic pressure experienced was about 12 percent higher than that shown as "planned".

The orbital portion of the trajectory, shown in figure 12, was obtained by starting with the spacecraft position and velocity vector obtained during the second pass near Woomera, as determined by the Goddard computer using Mercury network tracking data. Integration backward along the flight trajectory to orbital insertion and forward to the start of retrofire at the end of the third yielded the calculated orbit. These integrated values were in excellent agreement with the General Electric-Burroughs guidance system measured values at orbital insertion. They were also in accord with the position and velocity vectors determined by the Goddard computer for passes near the Canary Islands (first pass), Bermuda (second and third pass), and Muchea (during the third pass), thus establishing the validity of the integrated orbital portion of the flight trajectory.

The reentry portion of the trajectory, shown in figure 13, was obtained by starting with the spacecraft position and velocity vector near Corpus Christi, Texas, as determined by the Goddard Computer. Integration backward along the flight to the end of retrofire and forward to landing yielded the reentry trajectory. This exercise assumed that the retro-package had not been jettisoned and that the drogue chute was deployed at 04:49:17 GMT (given by telemetry) at an altitude

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of approximately 27,000 feet, instead of the planned altitude of 21,000 feet. The spacecraft decelerations from the integrated reentry trajectory agree within reading accuracy, with the decelerations measured by the onboard accelerometer. In addition, the times of drogue and main chute deployment from the integrated reentry trajectory and from spacecraft onboard measurements agree within one second. This agreement between the spacecraft serves to verify the validity of the integrated reentry portion of the trajectory. The integrated valves at the end of retrofire were adjusted by adding the effects of a nominal retrorocket total impulse of 38,360 lb-sec at nominal spacecraft retrofire attitudes of -34° pitch, with zero roll and yaw. The results, when compared with the orbital integrated values at the start of retrofire, show the velocity to be about 7 feet per second low indicating that the actual retrorocket performance was 7 feet per second greater. The fact that the spacecraft landed approximately 40 nautical miles short of the nominal landing point can be attributed to a deviation in spacecraft pitch attitude during retrofire and excessive retrorocket performance. An error of 1 foot per second in retro-velocity will give corresponding error in landing range of 5.2 nautical miles from the nominal landing point, and an error of 1.0° in pitch attitude during retrofire will give an error in landing range of 10.0 nautical miles from nominal. The reentry trajectory and the landing point

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were only slightly affected by the retention of the retropackage. The integrated landing point was about 4 nautical miles short of the spacecraft pickup point.

The aerodynamic parameters for the planned and integrated reentry trajectories were computed using the MSC model atmosphere. This is based on Discoverer Satellite program data above 50 nautical miles altitude, the 1958 ARDC model atmosphere between the 25- and 30-nautical mile altitudes, and the Patrick AFB atmosphere below 25 nautical miles altitude.

In the trajectory figures, the above integrated values are labeled "actual".

A comparison of the planned and actual trajectory parameters is given in table II. The difference between these is due to the actual cutoff velocity and flight-path angle being slightly lower than planned.

Guidance

The General Electric-Burroughs, Atlas guidance system performed excellently in this flight. The guidance system locked on the vehicle in both track and rate at 00:68, approximately as planned, and lost lock at 05:32, through 16, (31 seconds after sustainer engine cutoff, SECO).

In figure 14 the velocity and flight-path angle are shown in the

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region of sustainer cutoff. General Electric-Burroughs data are shown in figure 14, and the AZUSA data used in the Range Safety Impact Predictor Computer (IP 7000) are shown in figure 15 to illustrate the noise level during the time of the GO-NO-GO computations. Both the General Electric-Burroughs and the AZUSA data are considered excellent, except for two AZUSA points immediately after SECO.

The General Electric-Burroughs system gave a cutoff which was about 7 ft/sec low in velocity and about 0.50° low in flight-path angle. These values are within the expected accuracy range for the system.

In figure 16, these data are shown as flight-path angle versus velocity. This is the type of display used by the Flight Dynamics Officer in the Mercury Control Center for the orbital GO-NO-GO decision. Both General Electric-Burroughs and AZUSA data indicated a GO condition.

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TABLE 1. SEQUENCE OF EVENTS

Event	Planned Time, ¹ Hr:Min:Sec	Actual Time, Hr:Min:Sec	Difference, ² Seconds
Booster engine cutoff (BECO)	00:02:11.4	00:02:09.6	-1.8
Tower release	00:02:34.2	00:02:33.3	-0.9
Escape rocket firing	00:02:34.2	00:02:33.4	-0.8
Sustainer engine cutoff discrete (SECO)		00:05:02	-1.8
Tail-off complete	00:05:03.8	00:05:02	-1.8
Spacecraft separation	00:05:03.8	00:05:03.6	-0.2
Retrograde initiation	04:32:58	04:33:08	+10.0
Retrorocket no. 1 (left)	04:32:58	04:33:08	+10.0
Retrorocket no. 2 (bottom)	04:33:03	04:33:13	+10.0
Retrorocket no. 3 (right)	04:33:03	04:33:13	+10.0
Retropack jettison	04:33:53		
0.05 g relay actuation	04:43:53	04:43:31*	-22.0 (0) ³
Drogue parachute deploy	04:50:00	04:49:17.2	-42.8
Main parachute deploy	04:50:36	04:50:11	-25.0 (-1.0)
Main parachute jettison	04:55:22	04:55:23	+1.0 (-27.0)

¹Proflight calculated, based on nominal Atlas performance.

²The numbers in parentheses show the time difference between the actual event based on insertion parameters and the postflight-calculated reentry event.

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³The 0.05 g relay was actuated manually by astronaut when he was in a "small g field".

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TABLE II COMPARISON OF PLANNED AND ACTUAL TRAJECTORY PARAMETERS

Condition and Quantity	Planned	Actual	Difference
<u>Cutoff conditions (including tail-off):</u>			
Range time, seconds	303.3	302.0	-1.3
min:sec	05:03.3	05:02	
Geodetic latitude, deg north	30.4273	30.4533	0.0260
Longitude, deg west	72.3268	72.3065	0.0597
Altitude, feet	528,428	528,381	-47
nautical miles	87.00	86.96	-0.04
Range, nautical miles	436.4	433.7	-2.7
Space-fixed velocity, feet per second	25715	25702	-7.0
Space-fixed flight-path angle, deg	0	-.0468	-.0468
Space-fixed heading angle, deg			
east of north	77.4756	77.4826	.0070
<u>Post-postgrade firing conditions:</u>			
Range time, seconds	306.3	306.3	1.0
min:sec	05:06.3	05:06	
Geodetic latitude, deg north	30.4572	30.5128	0.0556
Longitude, deg west	72.3797	72.2923	-0.0874
Altitude, feet	528460	528361	-99
nautical miles	87.0	86.96	-0.04
Range, nautical miles	444.2	449.4	5.2

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TABLE II COMPARISON OF PLANNED AND ACTUAL TRAJECTORY PARAMETERS

Condition and Quantity	Planned	Actual	Difference
Space-fixed velocity, feet per sec	25737	25730	-7.0
Space-fixed flight-path angle, deg	-0.0030	-0.0517	-.0487
Space-fixed heading angle, deg			
east of north	77.5541	77.3399	0.0033
<u>Orbit parameters:</u>			
Perigee altitude, statute miles	100.1	100.03	-0.07
nautical miles	87.0	86.92	-0.08
Apogee altitude, statute miles	163.2	162.17	-4.03
nautical miles	144.4	140.92	-3.48
Period, min:sec	88:32	88:29	-00:03
Inclination angle, deg	32.32	32.54	0.02
<u>Maximum conditions:</u>			
Altitude, statute miles	163.2	162.17	-4.03
nautical miles	144.4	140.92	-3.48
Space-fixed velocity, feet per sec	25737.0	25732.0	-5.0
Earth-fixed velocity, feet per sec	24420.0	24415.0	-5.0
Exit acceleration, g's	7.7	7.7	0
Exit dynamic pressure, lbs/ft ²	966 ¹	962	16.0
	378 ²		
Entry deceleration, g's	7.6	7.7	0.1

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TABLE II COMPARISON OF PLANNED AND ACTUAL TRAJECTORY PARAMETERS

Condition and Quantity	Planned	Actual	Difference
Entry dynamic pressure	447	472	25.0
<u>Landing point:</u>			
Latitude, deg:min	21°07'N	21°26'N ³	00°19'N
Longitude, deg:min	68°00'W	68°41'W ³	00°41'W

¹Based on Cape Canaveral atmosphere.

²Based on 1950 ARDC model atmosphere.

³"Actual" landing coordinates shown above were those resulting from the trajectory integration. The retrieval point 20 minutes after landing was reported as 21°25'N and 68°37'W by the recovery ship (see section 9.0).

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SPACECRAFT PERFORMANCE

The spacecraft as an entity performed adequately. Some malfunctions were experienced, and analyses of these are discussed in the following paragraphs. Also discussed, from an overall mission viewpoint, are the spacecraft systems' general performance. Flight data and measurements are generally not shown, other than to clarify an analysis or present measurements of particular interest.

Complete time histories of spacecraft data, without analysis, are presented in reference 1.

Spacecraft Control System

With the single exception of both 1-pound yaw thrusters failing, the spacecraft control system functioned normally throughout the flight. Discrepancies between the attitude indicators and the ground reference reported by the astronaut are discussed and a detailed analysis of the thruster malfunction is presented in the Reaction Control section.

System description. - The spacecraft is capable of the following control system modes:

1. Automatic stabilization control system (ASCS), with orbit mode, orientation mode, and auxiliary damping mode.
2. Fly-by-wire (FBW) manual system.
3. Manual proportional (MP) system.
4. Rate stabilization control system (RSCS).

Modes 1 and 2 employ the automatic reaction control system (RCS)

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thrusters, while 3 and 4 use the manual RCS thrusters. Each reaction control system is independent of the other. Combinations of 1 and 3, 2 and 3, or 2 and 4 may be used simultaneously. The amplifier-calibrator (AmpCal) incorporated a new single-pulse, orbit-mode logic, thus eliminating the double orbit pulses that have been experienced in the past with dirty repeater sectors. In addition, the horizon scanner reference levels were set at approximately 25 percent to lessen cold cloud effects, and scanner slaying was programed for 8.5 minutes in each 30-minute period.

Flight description and analysis.-

Powered flight and turnaround: Control system operation was normal in this period, although the 5 seconds of separation rate-damping was delayed 2.5 seconds by the sequence circuitry associated with the .20g switch, thus leading to a fairly large initial roll error at the start of turnaround. The source of this error was the reopening of the .20g relay when posigrade thrust acceleration was sensed, and a lockout feature will be included on future flights. Turnaround was managed adequately, although the time required (38 seconds) to settle into orbit mode was longer than normal because of the initial roll error. Spacecraft attitudes and rates near insertion are listed in the following table:

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Axis	Attitude:Rate		
	Separation	Separation plus 2.5 sec (start of damping)	Separation plus 7 sec (start of turnaround)
Roll	0°:-1°/sec	-12°:-6°/sec	-22°:
Pitch	-8°:+0.4°/sec	+2°:+5.5°/sec	+4°:
Yaw	180°:-0.3°/sec	170°:-2.5°/sec	160°:

Orbital phase: Except for the thruster malfunction, the control system during this phase functioned essentially as designed. Control system exercises and usage modes are discussed in a later section. With the initiation of the first yaw maneuver, attitude indicators began to disagree with true spacecraft attitudes. Such disagreements are inherent in the system and will occur whenever the yaw or roll attitudes deviate from 0° for an extended period of time, as demonstrated mathematically and with operational hardware. Values will be different, depending upon the presence of either scanner slaving or fixed pitch orbital precession, but the effects will be similar. Each disagreement has been examined and can be explained per system design.

The following hypothetical maneuver is cited to best illustrate this point:

Assume that the spacecraft and gyros are properly erected in the normal orbit attitude and that the spacecraft is then yawed 90° and maintained in this yaw heading for $\frac{1}{8}$ of an orbital period (11.25 minutes or 45° orbital travel),

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while the astronaut maintains a local vertical using the window reference. During this $\frac{1}{8}$ pass the fixed pitch precession signal (about $4^\circ/\text{min}$) will drive the vertical gyro spin axis in a direction 90° from the orbital plane, and at the end of this period the pitch attitude indicator will disagree with the spacecraft true attitude by 45° .

At the same time, the astronaut will have rolled the spacecraft 45° to maintain his vertical position with respect to the local horizon. If the spacecraft is then restored to the normal orbit attitude, the gyro spin axis will maintain its position in space. This results in permanent attitude errors in both axes, unless corrected by slaving.

The 180° yaw maneuver, initiated at 3:14:00 is offered as the best example of the above (see figure 17). Indicated attitude errors, produced by spacecraft maneuvering, can be avoided by leaving the gyros caged during such maneuvers. New gyro references can best be restored through continuous scanner slaving, combined with incaging the gyros at approximately 0° pitch and then permitting the spacecraft to remain at orbit attitude (-34°) for approximately five minutes.

Three gyro cagings were executed by the astronaut during his mission phase. In each instance the spacecraft was pitched down to -15° , rather than level. In addition, during the first caging the spacecraft roll attitude was -19° .

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Horizon scanner operation was as expected, with short roll scanner "ignore" periods occurring just prior to sunset. All "ignores" produced by the pitch scanner can be correlated with maneuvers. Eight scanner slaving cycles occurred, which were controlled by the programmer, and this promptly removed all maneuver and caging errors.

Retrofire: Retrofire occurred at 4:33:08 and was completed by 4:33:33. The astronaut provided backup to the ASCS system with manual proportional control, maintaining slightly better attitudes than were experienced on the MA-5 mission. Pitch and roll was held to within 1° , with the yaw deviation not exceeding 2° .

.05g and reentry: At 4:39:39, reentry pitch-up was initiated by the astronaut, with the .05g relay manually actuated at 4:43:31. The .05g roll rate was initiated at 4:44:41, utilizing both manual and fly-by-wire thrusters, and reached $-11^{\circ}/\text{sec}$ within 2 seconds. By 4:46:30, pitch and yaw oscillations, with a period of 1.5 sec, were in evidence, with rates changing $2^{\circ}/\text{sec}$. The astronaut attempted to provide damping utilizing both manual and fly-by-wire thrusters. By 4:47:17 the pitch oscillatory rates had increased to greater than $10^{\circ}/\text{sec}$, with a period of 1.1 sec, while yaw rates were kept within $6^{\circ}/\text{sec}$ at the same frequency until 4:47:20, when they also exceeded $+10^{\circ}/\text{sec}$. It is estimated that manual fuel depletion occurred at 4:47:04. Analysis of stick motions and rates shows that at least 50 percent of the thrust pulses opposed the direction of motion, 25 percent were approximately 90° out of phase; thus decreasing then aiding; and producing no net effect. The remaining

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25 percent actually assisted in increasing the oscillations. Extrapolation of the rate traces provides a spacecraft swing of $+5^{\circ}$ in the center of this time period.

At 4:47:39, the astronaut switched on the auxiliary damping system. Pitch and yaw oscillation rates decreased to within $2^{\circ}/\text{sec}$ in a 4-second period, while the roll rate decreased from $-20^{\circ}/\text{sec}$ to a nominal $-11^{\circ}/\text{sec}$. At 4:48:32, the oscillations again began to build up in pitch and yaw. By 4:48:40, rates were changing $\pm 10^{\circ}/\text{sec}$, with a period of 3.5 seconds per cycle, while the roll rate showed an irregular decrease. Automatic system fuel depletion is estimated to have occurred at approximately 4:48:30. For future mission, flight plan ground rules will ensure that sufficient fuel will be available to control adverse oscillations in the auxiliary damping mode, with RSCS as a backup. At approximately 4:49:17, the drogue chute was deployed, with antenna fairing release and main chute deploy occurring at 4:50:11.

Behavior during the second period of oscillation compares with estimates for reentry without control, although the direct cause of the divergent oscillations cannot be conclusively determined. Gross extrapolations of flight data provide a spacecraft swing of about $\pm 25^{\circ}$ in pitch and at least $\pm 40^{\circ}$ in yaw (Astronaut Glenn estimated amplitudes of up to 90°). It was not possible at this point in the flight to determine attitudes with respect to the vertical, since the spacecraft gyros had been de-energized.

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Reaction Control System.-

Configuration: The Reaction Control System (RCS) was of the standard configuration in both the automatic and manual subsystems. Heat sink modifications to reduce temperatures in the hydrogen peroxide feed-line to the automatic and manual roll thrust assemblies were incorporated on the launch pad.

Prelaunch Activities: Prelaunch servicing of the manual and automatic subsystems was normal, with all components functioning properly during system servicing operations and thrust chamber static firings. One abnormality was a high decomposition rate from the automatic subsystem during surveillance. The actual surveillance rate evolved was 99 percent of the system allowable maximum; however, because of the decomposition rate linearity with time, the system was considered flight-worthy.

Flight Performance: Prior to 01:29:24, both the automatic and manual RCS subsystems functioned properly and delivered the expected thrust levels along all axes. At 01:29:24 (during the first orbital pass), the ASCS called for 1 pound yaw-left automatic thrust chamber operation from which no rate response was received for 5 orbit-mode pulse signals. Immediately after this malfunction, the astronaut selected the manual proportional control mode and returned the spacecraft to proper yaw attitude. Repeated signals to the thrusters in both ASCS and fly-by-wire control modes substantiated that the 1-lb yaw-left chamber was not functioning properly. This condition persisted until 01:48:22 when in

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the fly-by-wire mode, this thruster began to function and deliver the proper rate response. Except for a few isolated pulses of possible low thrust values, the 1 pound yaw-left operated properly for the remainder of the flight.

Within one minute and eighteen seconds of return to proper operation by the 1 pound yaw-left chamber, the 1 pound yaw-right chamber ceased to respond (01:49:40) in both ASCS and fly-by-wire control modes. The 1 pound yaw-right chamber remained inoperative for the duration of the flight, except for apparent intermittent operation in the period between 04:30:00 and 04:34:00.

With the exception of the 1 pound yaw thrust chambers, all remaining chambers in both the automatic and manual subsystems functioned properly throughout the flight with no notable exceptions. At one time the astronaut voiced the opinion that a possible pitch-thrust-chamber malfunction was evident, but this report was not substantiated by the data. The manual proportional control system exhibited proper operation at all times, with the possible exception of an instance where it appeared that the control handle may have retained a slight deflection from neutral following a control maneuver. This condition appeared to have been corrected by the astronaut with no difficulty.

Feed-Line Temperatures in Flight: Feed-line temperatures of both automatic 1-pound roll and manual-roll thrust chambers were measured during flight. The manual roll feed-line temperature increased approximately 30° F from prelaunch ambient conditions due to aerodynamic heating

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during powered flight. At the completion of spacecraft turnaround, manual roll feed-line temperatures were stable at approximately 106° F.

Automatic 1-pound roll feed lines were only slightly affected by the boost phase and indicated a total temperature increase of less than 10° F from prelaunch ambient to completion of spacecraft turnaround. Maximum temperature in orbit of the manual roll feed lines was approximately 106° F. Maximum temperature in orbit of the automatic roll feed line was approximately 120° F. The effect of solar radiation on feed line temperatures was evident from data taken during the second and third passes. During sunlight periods, slightly increasing temperature trends were noted, and in periods of darkness temperatures did not show an increasing trend.

Reentry heating effect on all instrumented feed lines was very pronounced, with manual roll reaching a maximum of approximately 145° F and automatic roll a maximum of approximately 200° F.

Postflight Inspection: All thrust chamber assemblies in Spacecraft 13 were disassembled on February 26, 1962, for the purpose of visual examination. Photography of noted observations was conducted concurrently with disassembly. Loose foreign particles found upstream of the fuel-metering orifices of both 1-pound yaw thrusters are believed to be the most probable cause of the intermittent malfunction of these thrusters. These foreign particles have been visually identified as portions of fuel distribution (Dutch weave) screens located downstream of the fuel metering orifices. The time and method by which these

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particles went upstream of the fuel orifice is unknown, but it is hypothesized that pressure transients in the thrust chambers provided the transport mechanism. Examination results are listed in table III, and typical photographs are shown in figure 18. For the MA-7 mission, what is commonly referred to as the "interim fix" has been incorporated into the reaction control system for spacecraft 18. This essentially involves replacing the stainless steel Dutch weave screens with platinum screens and a fuel distribution plate, reducing the volume of the heat barriers and solenoids, and moving the orifice to the solenoid inlet.

Fuel Consumption: The fuel consumption is shown in table IV, and the reentry portion is shown in figure 19.

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TABLE III. - RESULTS OF POSTFLIGHT EXAMINATION OF THRUST CHAMBER

Thrust Chamber Assembly	Heat Barrier Screen	Orifice Condition	Dutch weave Condition	Remarks
1 pound Yaw Right, S/N 101	Clear	5 particles on upstream face	Top screen burned and heavily eroded in center	Particle diameter approx. same as .016 orifice and length somewhat larger than .016
1 pound Yaw Left, S/N 55	Clear	Numerous dust size parti- cles on upstream face	Top screen burned and moderately eroded	Particle size of the order 100 to 200 microns
1 pound Pitch Down, S/N 114	Clear	1 particle on upstream face	Small hole in top screen. Slightly burned	Particle size of the order 100 to 200 microns
1 pound Pitch Up, S/N 108	Clear	9 particles on upstream face	Top screen burned and practially eroded in center	Particle size same as 1 pound Yaw Right, above
1 pound Roll CCW, S/N 12	Clear	Clean	Normal - only slightly discolored	
1 pound Roll CW, S/N 211	Clear	Clean	Normal - only slightly discolored	
Auto - 6 pound Roll CW, S/N 211	Clear	Clean	Normal	
Auto - 6 pound Roll CCW, S/N 12	Clear	Clean	Slight erosion	

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TABLE III.- CONTINUED

Thrust Chamber Assembly	Heat Barrier Screen	Orifice Condition	Dutch weave Condition	Remarks
Auto - 24 pound Pitch Up S/N 241	Clear	Clean	NA	
Manual - 24 pound Pitch Up, S/N 215	Clear	Clean	NA	
Auto - 24 pound Pitch Down, S/N 12	Clear	Clean	NA	
Manual - 24 Pound Pitch Down, S/N 205	Clear	Clean & Wet	NA	
Auto - 24 pound Yaw left, S/N 107	Clear - appears as only 1 screen	Clean	NA	
Manual - 24 Pound, Yaw Left, S/N 85	Clear	Clean	NA	
Auto - 24 pound Yaw Right, S/N 54	Clear	Clean	NA	
Manual - 24 pound Yaw Right, S/N 213	Clear & wet	Clean & wet	NA	

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TABLE III. - CONCLUDED

Thrust Chamber Assembly	Heat Barrier Screen	Orifice Condition	Dutch Weave Condition	Remarks
Manual - 6 pound Roll CCH, S/N 2	Clear & wet	Clean	Normal	
Manual - 6 Pound Roll CW, S/N 7	Clear & wet	Clean	Normal	

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~~CONFIDENTIAL~~TABLE IV.- FUEL CONSUMPTION^a

Maneuver or Mode	Auto System		Manual System	
	Fuel Used lbs	Fuel Remain lbs	Fuel Used lbs	Fuel Remain lbs
00:00:00 Launch	0	36.0	0	24.4
00:06:00 Turnaround and damping	5.8	30.2	0	24.4
01:37:00 Orbital Pass 1	4.2	26.0	0.6	23.8
03:10:10 Orbital Pass 2	6.0	20.0	11.8	12.0
04:33:00 Orbital Pass 3 (to retro)	8.6	11.4	5.2	6.8
04:43:27 Retro to .05g	4.0	7.4	5.6	1.2
04:49:20 .05 to drogue parachute deploy	7.4 ^b	0	1.2 ^b	0
04:50:11 Drogue parachute to main parachute	0	0	0	0

^aData accuracy to ± 0.5 pound fuel.^bFuel depletion occurred during this period~~CONFIDENTIAL~~

Postflight examination of data recorded onboard revealed that the automatic fuel depleted near 04:48:30 and manual at approximately 04:47:20. The manual fuel quantity indicator averaged an error of approximately 8 percent more fuel than actual for fuel quantities below 70 percent. The automatic fuel quantity indicator averaged an error of approximately 3 percent more fuel than actual for all fuel indications. Neither of the above percentage errors reflects a visual reading error of the FQI gauges.

Environmental Control System

The Environmental Control System (ECS) provided adequate environmental conditions for the astronaut throughout the flight. The uncomfortably warm conditions reported by the astronaut after landing are discussed in a later section.

System Description.- The primary change in the ECS from spacecraft no. 9 (MA-5) was the addition of a constant-bleed orifice to the suit circuit. This orifice provided a continuous oxygen flow greater than the astronaut's anticipated metabolic requirement. The excess gas was exhausted into the cabin.

Countdown.- The temperature of the main inverters increased to higher than expected levels during the countdown. This indicated that the freon flow to the inverter cold plates, though adequate during pre-count checks, was inadequate during the final count. Temperatures of the 150-v amp and 250-v amp inverters at lift-off were 162° F and 120° F, respectively.

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Launch Phase.- The launch phase was normal. The cabin and suit pressures maintained a 5.5 psi differential above ambient during ascent and held at 5.7 and 5.8 psia, respectively.

Orbital Phase.- Cabin and suit pressures maintained 5.7 and 5.8 psia, respectively, throughout the orbital flight. The decay in these pressures that had been observed in previous flights was absent for three primary reasons:

1. The low cabin leakage (less than 500 cc/min.).
2. Excess oxygen, exhausted into the cabin from the suit circuit constant-bleed orifice.
3. Minor leakage from the secondary oxygen supply.

The oxygen partial pressure agreed with suit pressure to within 0.5 psia although it was consistently lower. The cause of part of this difference is contributed by water vapor in the suit circuit, which added a partial pressure of approximately 0.3 psi that is not included in the oxygen partial pressure measurement. A more careful calibration than those made for previous flights has resulted in a more satisfactory performance of this instrument.

The cabin air temperature, after the initial heating period, fluctuated as expected when the spacecraft passed through the alternate periods of darkness and sunlight. The astronaut reported that at least five attempts to reduce cabin air temperature, by increasing water flow to the cabin heat exchanger resulted in illumination of the excess water light. This indicated that the cabin heat exchanger was operating near

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its maximum capacity for the existing conditions. Nevertheless, the mean cabin air temperature was steadily reduced after the first hour in orbit.

The suit inlet temperature (figure 20) varied between 65° and 75° F during the orbital phase. The astronaut reported a coolant flow of 1.7 pounds/hour to the suit heat exchanger, and a stream exhaust temperature of 65° F. These values are both higher than anticipated and contradict each other, since freezing of the exchanger would be expected at this flow rate. No explanation of this anomaly can be offered at this time.

The 150- and 250-v amp inverter temperatures (figure 20) increased steadily from the launch values of 162° and 120° F, to 204° and 197° F, at landing, respectively. Postflight testing revealed that the check valve between the coolant supply and the cold plates was stuck in the closed position and would not permit the coolant to flow to the cold plates in orbit. The coolant tank was charged with 25 pounds of water before the flight. The coolant quantity indicating system showed a usage of 7.2 pounds. Postflight weighing indicated a usage of 11.8 pounds. The difference in calibration and final system temperatures can account for about 3.8 pounds of the 4.6 pounds discrepancy, while the remaining 0.8 pounds is considered to be instrument error.

Reentry and Postlanding. - The maximum cabin temperature during this period was 103° F, which is undesirable but satisfactory. The suit inlet temperature increased to 86° F during the postlanding phase. This

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value is reasonable since the air temperature in the landing area was 76°, and the suit compressor raises the temperature in the suit circuit by approximately 10° F. The sequence of operation regarding cooling techniques during this period will be modified to reduce the suit inlet temperature to a more tolerable level.

Anomalies.- Examination of the flight data and postflight checks of the environmental control system have revealed several anomalies. As shown in figure 21, the secondary oxygen supply exhibited an unexpected decay in pressure, which was first noted after approximately 01:50:00. However, it is not known when this decay began, since the secondary oxygen bottle was serviced to about 8,000 psig before flight, and the pressure transducer had a maximum indicating value of only 7,500 psig. The indicating range of future transducers will be increased to 10,000 psig. Postflight tests indicated that the secondary system was free of leaks. Also, the postflight checks indicated a usage rate of only 0.13 pounds per hour through the suit circuit, compared with about 0.18 pounds per hour obtained during prelaunch tests. Finally, the pressure decay rate of the primary supply decreased to much lower than expected values during the final portion of the mission, and, during the last three quarters of an hour in orbit, the decay rate of the secondary supply was essentially zero. No explanation for these anomalies can be offered at this time, but investigations are being conducted to isolate and reveal the source of this anomaly.

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Mechanical and Rocket Systems

All systems functioned normally, with the exception of early drogue chute deployment and an indication of heat shield deployment during orbital flight. These anomalies, along with general systems performance, are discussed in the following paragraphs.

Parachutes. - The performance of the drogue and main parachutes upon deployment were satisfactory. Since neither parachute was recovered, a detailed postlaunch visual inspection could not be made. However, observation by the astronaut verified that both parachutes were deployed cleanly and were undamaged during descent. The main chute deployed at a pressure altitude of 10,000 feet, as determined from pressures measured onboard. This is within the specification limits of $10,000 \pm 750$ feet.

The drogue parachute deployed at a higher-than-normal altitude, probably about 27,000 feet pressure altitude. Onboard pressure measurements (commutated) indicate a pressure altitude of approximately 29,000 feet at the time of drogue chute deployment, and the integrated trajectory is consistent with a drogue deployment at about 27,000 feet. The astronaut reported an altitude of 30,000 to 35,000 feet indicated at the time of drogue deployment. The astronaut stated that he had raised his arm approximately halfway to the drogue deploy switch to manually initiate drogue deployment when it occurred automatically. The drogue chute barostats actuated properly within specification pressure altitudes of $21,000 \pm 1,500$ feet in postflight tests.

The possible causes of an early deployment of the drogue parachute

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were isolated to those listed below and investigated separately.

1. Inertial barostat actuation as a result of high spacecraft oscillation.
2. Dynamic pressure (q) effects caused from tumbling of the spacecraft.
3. Actual astronaut actuation of the manual drogue parachute switch.
4. Structural failure within the parachute compartment, particularly the drogue mortar cover.
5. Static pressure buildup in the parachute compartment.
6. Spurious or random signals in the drogue mortar-firing circuit.

The first source was ruled out after comparison of the estimated 2g acceleration imposed by the spacecraft oscillations with the rigid qualification specifications governing on the flight hardware. Strong evidence exists that a dynamic pressure could^{not} have built up without being sensed by the static pressure transducer in the parachute compartment. Item 3 was eliminated as a cause through postflight interviews with the astronaut and examination of photographs taken in the spacecraft during the period in question. Postflight examination of the parachute compartment revealed no structural failure, and recorded sequence data indicates that the mortar was fired by a nominal electrical signal, disproving item 4. Tests at McDonnell Aircraft have shown that any oscillatory pressure buildup in the parachute compartment is sensed by the pressure transducer, and, therefore, this would have been evident

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on the flight record. The last item represent the most plausible cause. Postflight tests have shown the entire circuitry to be sound, however, these tests were conducted under static conditions and are therefore inconclusive.

Rockets and Pyrotechnics.- A postflight examination of the spacecraft and an analysis of the pertinent data indicates that all rockets and pyrotechnics functioned as intended. It cannot be determined whether certain pyrotechnics actually fired (such as redundant clamp-ring bolts and tower jettison rocket ignition), since the available evidence shows only that the resulting function was satisfactory.

Explosive-Actuated Hatch.- After the spacecraft was secured onboard the recovery ship, the astronaut initiated the hatch explosive-mechanism through the use of the internal actuator on the hatch. The hatch appeared to have fired satisfactorily.

Ablation Shield.- Reentry heating for spacecraft 13 (MA-6) is considered to be nearly identical to that experienced on spacecraft 9 (MA-5). Since heating data recorded during the MA-6 reentry is unavailable at this time, the results of the MA-5 reentry temperature survey are presented in figure 22. Temperature readings on the conical and cylindrical portions of the spacecraft employed thermocouples spot welded to the inboard side of the exterior shingles. It should be noted that this is the first formal publication of the MA-5 reentry heating data. These data are currently being analyzed, with a detailed report of the study forthcoming.

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Landing Bag. - The landing-attenuation system performed normally, as evidenced by the astronaut's statements and from postflight examinations. The landing bag was found to be torn in several places from unknown causes, but no restraining cables or straps were broken. The usual minor damage to ablation shield retaining studs and to the bulkhead-protective shield was experienced. The main pressure bulkhead was undamaged except for a small dent near the center.

Heat Shield-Deploy Mechanism. - A comprehensive postflight inspection of the limit switch circuitry and hardware revealed that both lateral and axial translation would generate a signal, although the switch is designed to actuate only after a rotational deflection. The cause of this improper operation was traced, after disassembly, to a poorly machined shaft (see fig. 23). The shaft was dented in several places and bent some five or ten degrees. Quality control and production techniques of future limit switches will be improved. The pilot reported noises and other indications of heat shield deployment when he manually initiated the heat shield deployment at $2\frac{1}{2}$ minutes after main chute deployment, thus leading to the conclusion that the shield mechanism was not unlatched in orbit.

Electrical and Sequential Systems

Electrical System. - The spacecraft electrical system was of a specification configuration. One-ohm fuse resistors were installed in all squib firing circuits. Inverter monitor lights were installed to tell the astronaut when the 150 v-amp and 250 v-amp inverters were

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operating. Main bus voltage and d-c current were as expected throughout the mission. Fans and ASCS a-c bus voltages were also normal.

The inverter temperatures were about 162° F on the 150 v-amp inverter and 120° F on the 250 v-amp inverter at lift-off and increased gradually throughout the mission to 212° and 203°, respectively. This indicated that the inverters received little or no inflight cooling. Inverter cooling is discussed in a previous section.

Sequential System.- The sequential system performed as was expected during the flight, with the following exceptions:

1. Spacecraft separation (T/M segment 47), cap-sep telelight, periscope extend, and damping command to the ASCS were received three seconds after the spacecraft separation indication from booster telemetry. The time discrepancy is attributed to MA-6 not having electrically latched spacecraft adapter bolt fire relays to keep the spacecraft separation circuitry armed during posigrade firing. Earlier spacecraft had this latching feature, as will subsequent spacecraft.

2. The heat-shield-deployed indication (segment 51) on telemetry was realized prematurely, and it then cycled ON-OFF several times during the flight. This was caused by a defective left-hand limit switch. In addition to the mechanical failure of the limit switch, the circuit design did not provide for optimum reliability with the two redundant switches installed. Therefore, future limit switch circuits will be modified such that both switches must actuate to generate a shield-unlocked signal. The landing bag was deployed manually by the astronaut at about 2 $\frac{1}{2}$ minutes after main-chute deploy and functioned properly.

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3. Reentry was performed with the retropack attached. This prevented the .05g event from occurring automatically, which was initiated manually by the astronaut. Retropackage separation indications did not occur, since the electrical signal to fire the retropack separation bolt was never given. This caused the cameras to remain on high speed from retroattitude command until power was removed after impact.

4. The drogue chute was deployed prematurely at about 27,000 feet. The 21,000 foot barostats were removed after the flight, subjected to a pre-installation acceptance test, and found to be functioning properly. Further tests of the static system were performed and are discussed in the Mechanical Systems section of this report.

Telemetry and Recording Systems

The instrumentation system flown on the MA-6 mission was essentially the same as in the MA-5. Small changes between the two spacecrafts were required to accommodate those parameters associated with a manned mission. Other changes are as follows:

1. Heat shield temperature for MA-6 was measured by means of a chromel-alumel thermocouple.
2. The MA-6 spacecraft contained only two cameras, the pilot-observer and instrument-observer, deleting the earth-sky and periscope cameras.
3. A different type of color film was used in the pilot-observer camera.

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4. For MA-6, the mixed sequence of events were superimposed on the vernier-clock signal.

A complete list of the instrumented parameters is included in table V.

Telemetry.- Both telemetry transmitters exhibited a center-frequency shift and signal strength rise when the escape tower was jettisoned. This effect, resulting from a change in antenna VSWR, was anticipated and will be taken into account when setting the center frequencies for the transmitters on future spacecrafts. The change in VSWR is generally not significant enough to prevent the transmitters from being adjusted to bring the center frequencies within specification for both tower-on and tower-off conditions. The signal strengths and deviation from center frequency, as read by AMR when the spacecraft passed over Cape Canaveral, are shown in table VI.

Data quality.- The quality of the data reduced from the onboard tape was very good. Scatter and noise caused by tape speed variations was insignificant and easily compensable on the continuous channels. The only problem area occurred during the time of exit maximum dynamic pressure, at which point the vibrational affects on the recorder caused almost complete loss of data. However, the real-time data during the same period covers the lapse.

A comparison of the hand controller (stick position) data, as instrumented on continuous and commutated channels, shows the definite advantage of instrumenting this parameter by means of a continuous

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channel. About 50 percent of the stick position data are lost on the commutated channel, and that which remains is difficult to interpret.

Photographic.- The instrument-observer camera malfunctioned during the 60-second test at T-55 minutes in the countdown. The film slipped out of the film gate while the camera continued to run, which indicated it was operating properly. This camera, which does not yield significantly useable data, will be removed in future flights. The results obtained from the pilot-observer camera were satisfactory. The use of the Ektachrome ER, color film is an improvement over previously used types.

Onboard timing.- The vernier-clock channel malfunctioned throughout the entire flight. Each time the pilot-observer camera operated, a spurious pulse was produced in the vernier clock signal. At times when the camera operated at high speed, the signal was rendered nearly useless. The satellite clock is presently being redesigned to include a 1-PPS output, which can be used to directly modulate the voltage-controlled oscillator. The new design will utilize, as a trigger, the same 28-v d-c signal which steps the clock digital counters. This will result in a great improvement in signal-to-noise ratio and should eliminate the problem.

From the instrumentation standpoint, the most serious problem resulting from the MA-6 mission was in the respiration rate and depth channel. The principle of operation of the circuit is a thermistor sensor which is heated by a d-c voltage. When the subject breathes on

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the sensor, it cools and changes resistance, producing a voltage change on the output of a direct-coupled transistor amplifier. The basic problem is that the thermistor temperature is subject to changes in ambient temperature and flow. Because of changes in these quantities, the baseline of the respiratory signal varied from a value of 10 percent, which was set during the suiting procedure, up to a maximum of 85 percent at lift-off. After lift-off, the baseline fell steadily until it reached a low of 10 percent at 02:08:00. It then began to rise again and had attained a 40 percent level at loss of signal. The sensitivity of the signal degraded in direct proportion to the baseline shift, since the sensitivity decreases as the baseline increases. The sensitivity problem is further complicated by the fact that the position of the sensor is not fixed to the position of the pilot's head. In the MA-6 mission, much of the data were lost because the pilot was not breathing directly on the sensor. Both the subcarrier oscillators which encoded the respiration data performed within specification and did not contribute to the above effects.

Vibration

Vibrations measured during the powered flight phase of the MA-6 mission were almost identical with those experienced during the MA-5 mission. These vibrations can be seen as oscillations on the spacecraft pitch-rate gyro output, as shown in figure 24. The information available indicates that the astronaut's performance was not impaired by these vibrations.

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Postflight Inspection

The general condition of the spacecraft was excellent as indicated in figure 25. The exterior of the spacecraft showed the usual slight discoloration caused by aerodynamic heating. Also, there were deposits of 2024 aluminum alloy which had evidently been deposited in a molten state and adhered to the surface of several widely separated shingles. The aluminum retropack cover is undoubtedly the source of these deposits. A brownish deposit was found on a portion of the spacecraft window exterior surface. The nature of this deposit has not been determined. As on previous flights, the window was found to be fogged with water condensate between the two outer panes.

Structure. - The spacecraft did not experience any structural damage which would have compromised the safety of the mission in any way.

Ablation shield. - The external surface of the shield (see figure 26) had charred in the normal pattern. The center plug of the shield had separated and extended outward approximately 0.5 inch, as in previous missions. A pie-shaped segment of the shield is of a darker background color than the adjacent area. The same area contains several radial marks approximately 4 inches in length. It is likely that a large piece of the retropack slipped off in this direction. There are two small deposits, metal-like but of undetermined composition, on the shield.

Heat-shield deployment instrumentation. - The heat-shield deploy switch between stringers 2 and 3 had a very loose rotary stem. The switch would make and break electrical contact when the rotary stem was

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moved up and down along its longitudinal axis. This malfunction could account for the impact-bag-deployed signal that was received during the flight, as discussed in an earlier section.

Landing bag.- The landing bag had several tears, and it was impossible to determine whether these occurred during landing or in postflight handling. Experts believe the most probable time of damage occurred during the landing-bag stowage operation aboard ship. No landing bag straps or cables were broken, but some straps were kinked. There was minor damage to the heat shield retaining studs and the bulkhead protective shield, probably from landing as in previous flights. However, no damage occurred to the spacecraft equipment in this area.

The large pressure bulkhead had a dent from an undetermined cause near the center approximately 1.5 inches long. The center area is not covered by the bulkhead shield.

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TABLE V.- COMMUTATOR POINT ASSIGNMENT FOR MA-6

COMM. HF	COMM. LF	PARAMETER	RANGE
1	1	3-volt reference	3 v
2	2	Zero ground reference	0.v
3	3	AC amplifier power supply monitor	7 v ac
4	4	Body temperature	95° - 107° F
5	5	Command receiver, all channels signal	On-Off
6	6	Oxygen partial pressure	0 - 800 mm Hg
7	7	"A" command receiver signal strength	0 - 80 μ volts
	7	"B" command receiver signal strength	0 - 80 μ volts
8	8	Suit pressure	0 - 15 psia
9	9	Oxygen supply pressure primary	0 - 7500 psig
10	10	Cabin air temperature	40° - 200° F
11	11	Suit inlet air temperature	40° - 100° F
12	12	Oxygen supply pressure secondary	0 - 7500 psig
13	13	Y-axis accelerometer (13, 43 and 73)	+ 0.5g, + 4g
14	14	X-axis accelerometer (14, 44 and 74)	+ 0.5g, + 4g
15	15	Z-axis accelerometer (15, 45 and 75)	+ 30g
16	16	Pitch attitude ASCS calibrator	-140° to + 180° F
17	17	Roll attitude ASCS calibrator	-130° to + 200° F
18	18	Yaw attitude ASCS calibrator	-70° to + 250° F
19	19	Roll CW manual - fuel line temperature	0 - 250° F
	19	Roll CCW manual - fuel line temperature	0 - 250° F
20	20	Lo roll CCW auto - fuel line temperature	0 - 250° F
	20	Lo roll CW auto - fuel line temperature	0 - 250° F
21	21	250 va inverter temperature	40° - 300° F
22	22	Static pressure	0 - 15 psia
23	23	Stick position roll	+ 13°
24	24	Stick position pitch	+ 13°
25	25	Stick position yaw	+ 13°
26	26	Elapsed time (10 seconds)	
27	27	"A" command receiver signal strength	0 - 80 μ volts
	27	"B" command receiver signal strength	0 - 80 μ volts
28	28	Elapsed time (1 minute)	
29	29	Elapsed time (10 minutes)	
30	30	Elapsed time (1 hour)	
31	31	Elapsed time (10 hours)	
32	32	150 va inverter temperature	40° - 300° F
33	33	Time of retrograde (10 seconds)	
34	34	Time of retrograde (1 minute)	
35	35	Time of retrograde (10 minutes)	
36	36	Time of retrograde (1 hour)	
37	37	Time of retrograde (10 hours)	

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TABLE V. - COMMUTATOR POINT ASSIGNMENT FOR MA-6 (continued)

COMM. HF	COMM. LF	PARAMETER	RANGE
38	38	Horizon scanner pitch ignore	On-Off
39	39	Reaction control supply pressure (auto)	600 - 2200 psig
40	40	Reaction control supply pressure (manual)	600 - 2200 psig
41	41	AC voltage monitor (fans bus)	95 - 120v ac
42	42	DC current monitor	0 - 50 amps
43	43	Y-axis accelerometer	
44	44	X-axis accelerometer	
45	45	Z-axis accelerometer	
46	46	Tower release	On-Off
47	47	Capsule separation	On-Off
48	48	Retro attitude command	On-Off
49	49	"A" command receiver signal strength	
		"B" Command receiver signal strength	
50	50	Retrofire timing signal	On-Off
51	51	Impact bag deploy	On-Off
52	52	Integrating accelerometer signal	0 - 600 ft/sec
53	53	Retro assembly jettison	On-Off
54	54	Drogue chute deploy	On-Off
55	55	Antenna fairing release	On-Off
56	56	Main chute deploy	On-Off
57	57	Main Chute Jettison	On-Off
58	58	Reserve chute deploy	On-Off
59	59	Pilot abort	On-Off
60	60	Mayday	On-Off
61	61	Tower escape rockets	On-Off
62	62	Standby inverter "On"	On-Off
63	63	ASCS slaving signal	On-Off
64	64	Calibrate Z/Cal, R/Cal(also 25%,50%,75% Ref.)	On-Off
65	65	High pressure reaction jet solenoids (+ pitch)	On-Off
66	66	High pressure reaction jet solenoids (- pitch)	On-Off
67	67	18-volt ISOL voltage	16 - 22v dc
		18-volt standby voltage	16 - 22v dc
68	68	Oxygen emergency rate mode	On-Off
69	69	High pressure reaction jet solenoids (+ roll)	On-Off
70	70	High pressure reaction jet solenoids (- roll)	On-Off

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TABLE V.- COMMUTATOR POINT ASSIGNMENT FOR MA-6 (continued)

COMM. HF	COMM. LF	PARAMETER	RANGE
71	71	"A" command receiver signal strength	On-Off
72	72	"B" command receiver signal strength	
73	73	Periscope retract signal	
74	74	Y-axis accelerometer	0° - 2500° F
75	75	Z-axis accelerometer	
76	76	Heat shield temperature (thermocouple)	
77	77	ASCS bus voltage	95 - 125v ac
78	78	High pressure reaction jet solenoids (- yaw)	On-Off
79	79	High pressure reaction jet solenoids (+ yaw)	On-Off
80	80	Retrorocket temperature	0° - 150° F
81	81	HF telemetry transmitter temperature	40° - 300° F
	81	LF telemetry transmitter temperature	40° - 300° F
82	82	Cabin pressure	0 - 15 psia
83	83	DC voltage monitor	18 - 28v dc
84	84	Coolant pressure	230 - 485 psig
85	85	Horizon scanner roll ignore	On-Off
86	86	Horizon scanner output monitor roll	+ 35°
87	87	*.05g relay actuation	On-Off
88	88	Horizon scanner output monitor pitch	+ 35°
89	89	Synchronize pulse	
90	90	Synchronize pulse	

TABLE V.- COMMUTATOR POINT ASSIGNMENT FOR MA-6 (concluded)

HIGH FREQ. SYSTEM	CONTINUOUS CHANNELS	RANGE
0.40	Roll rate and low roll thruster (mixed)	$\pm 10^\circ/\text{sec.}$
0.56	Vernier clock and sequence of events (mixed)	1-PFS
0.73	DC volts	18 - 28v dc
1.3	R.R. and D	
1.7	EKG (left side, right side)	
2.3	EKG and blood pressure (upper chest, lower chest)	
3.0	Reference	
3.9	Stick position, roll	$\pm 13^\circ$
10.5	High frequency commutator (PAM)	

LOW FREQ. SYSTEM	CONTINUOUS CHANNELS	RANGE
0.40	Pitch rate and low pitch thrusters (mixed)	$\pm 10^\circ/\text{sec.}$
0.56	Yaw rate and low rate thrusters (mixed)	$\pm 10^\circ/\text{sec.}$
0.73	D.C. Current	0 - 50 amp
1.3	R.R. and D	
1.7	EKG (left side, right side)	
2.3	EKG and blood pressure (upper chest, lower chest)	
3.9	Stick position pitch	$\pm 13^\circ$
5.4	Stick position yaw	$\pm 13^\circ$
10.5	Low frequency commutator (PAM)	

ON-BOARD TAPE RECORDER TRACK ASSIGNMENTS

TRACK	INFORMATION
1	Open
2	High frequency telemetry multiplex
3	Voice
4	PDM high frequency
5	PDM low frequency
6	Low frequency telemetry multiplex
7	Open

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TABLE VI. - TELEMETRY SIGNAL STRENGTH

Mission Phase	S/S, DEM		Deviation ^a from center frequency, kc	
	Low	High	Low	High
Lift-off	-30	-30	+13.9	-45.2
Tower release	-52	-52	-1.0	-29.0
First pass	-35	-52	-5.0	-21.5
Second pass	-30	-45	-3.0	-20.9
Third pass	-60.5	-55.5	0	-18.0

^aSpecification deviation: High link,
±26 kc; low link, ±22 kc

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LAUNCH VEHICLE PERFORMANCE

All booster systems performed satisfactorily. The following items are noted for information.

Abort Sensing and Implementation System (ASIS)

The ASIS performed satisfactorily. None of the abort parameters was near its abort threshold. As expected in normal sequence, an ASIS abort signal was generated following SECO (sustainer engine cutoff).

Engine Cutoff

SECO and ASCO (auxiliary sustainer cutoff) signals were transmitted, and at least one was received and properly acted upon by the booster. Instrumentation does not permit determination of whether or not both signals were acted upon by the booster.

Booster Lifetime in Orbit

Computed data based upon probable thrust having been imparted to the booster tankage by the spacecraft posigrade rockets (-4 feet per second) indicated at least 10 orbital passes to be expected from the booster. The final stage tankage, however, was later found to have reentered some 6 passes following launch. Tracking during the third orbital pass indicated a perigee of about 95 nautical miles, an apogee of about 131.0 nautical miles, and a period of approximately 87 minutes. No useful tracking data were obtained after the fourth orbital pass.

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Aerodynamic loads.- The angle of attack times dynamic pressure (αq) for the flight is shown in figure 27 and is based on the measured wind profile at launch.

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AEROMEDICAL ANALYSIS AND FLIGHT ACTIVITIES

Introduction

This chapter reports in three sections the reactions of the astronaut during this first orbital mission. The first section contains a medical report covering the detailed medical examinations and an evaluation of inflight physiological data. These medical findings indicate that the pilot's reactions both during and after the flight were normal. The first section is followed by a report on the many diverse activities of the astronaut and his performance during the flight in controlling the spacecraft and making scientific observations. The chapter is concluded with a narrative account of the mission obtained from Astronaut Glenn within two hours after landing. The pilot discusses with clarity and good understanding the major events of the flight, expressing satisfaction with his ability to manually control the spacecraft.

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Aeromedical Investigations

The aeromedical investigations conducted with the MA-6 mission can be logically grouped into two distinct areas: (1) the preflight and postflight clinical examinations (static examinations) and (2) the preflight and inflight physiological studies (dynamic studies). These investigations are designed to ascertain the state of the astronaut's health and to provide information reflecting human responses to space flight. The MA-6 mission provided a sufficient period of weightlessness such that the pilot's physiological responses attained a relatively steady state. In the much shorter Mercury-Redstone Flights, little time was available in weightlessness for the astronaut's physiological adjustment mechanisms to stabilize.

The astronaut's activities during the time immediately prior to his insertion into the spacecraft have a moderate effect on his countdown and flight responses. For this reason his activities for the approximate nine-hour period prior to his arrival at the spacecraft are listed in table VII.

Astronaut Glenn began his 72-hour, prelaunch low-residue diet on February 16, 1962. On the night prior to flight, the pilot obtained 4 hours and 50 minutes of dozing, light sleep. No medication was administered.

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Clinical studies.- Detailed medical examinations were performed prior to the MA-6 flight, and similar investigations were conducted as soon after the flight as recovery practices permitted. Initial examinations were accomplished to determine the astronaut's state of health and his medical fitness for flight. In addition, such clinical evaluations serve as baseline medical data which may be later correlated with inflight physiological information.

The schedule and sources of medical data regarding Astronaut Glenn are listed below:

1. Prior physical examinations beginning with astronaut selection in 1959.
2. Detailed preflight clinical examinations conducted on January 22, 1962 and February 12, 1962.
3. Preflight examination conducted on launch morning.
4. Postflight medical evaluations on the recovery ships and at Grand Turk Island Medical Facility.

The numerous preflight examinations of Astronaut Glenn disclosed no significant medical abnormalities; his physical and mental health remained excellent throughout.

The postflight examination of the astronaut began with his emergence from the spacecraft onboard the Destroyer Noa some 39 minutes after landing. The pilot was described as appearing hot, sweating

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profusely and fatigued. He was lucid, although not talkative and voiced no medical complaints other than being hot.

After removal of his pressure suit and a shower, he became more communicative and described a mild sensation of "stomach uneasiness" or "stomach awareness" as having occurred during the 17 minutes while awaiting recovery. This sensation did not commence until after spacecraft landing and cleared spontaneously within $1\frac{1}{2}$ hours. Neither nausea nor vomiting was experienced. This stomach uneasiness can be attributed to several factors. One is the combination of temperature and humidity immediately after landing. The ambient air was at 76°F and 60-65 percent relative humidity, and the water temperature was 81°F. The suit inlet temperature was 85°F, and the cabin air temperature was 103°F. A second major factor is the moderate dehydration of the astronaut. This is evidenced by his weight loss (5-5/16 pounds vs. a pound loss during a three-orbit centrifuge simulation), diminished urine output with increased specific gravity for the 24-hour, post-recovery period, increased blood concentration, and the recovery physician's clinical impression.

The astronaut had a minimal fluid intake during the 13 hours from breakfast at 0250 to shipboard at 1545 e. s. t., since the equivalent of only 94 cc of water was ingested as applesauce puree. The only other intake during the flight was one 5.0 gram sugar (xylose) tablet for a test of intestinal absorption, the results of which

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were normal. His urine output during this period was 800 cc which he reported as voiding just prior to reentry. The fluid intake and output is shown in the following table:

FLUID INTAKE AND OUTPUT		
Urine output ^a	countdown	0 cc
	inflight	800 cc (Sp. Gr. 1.016)
	postflight (shipboard)	0 cc
		Total 800 cc
Fluid intake	countdown	0 cc
	inflight ^b	94 cc
	postflight (shipboard)	
	1545 hours ^c	265 cc iced tea
	1830 hours	240 cc water
	1850 hours	125 cc coffee
		Total 724 cc

^a See also Table V

^b 119.5 grams of applesauce puree (78 percent water).

^c All times are c. s. t., February 20, 1962.

A comparison of the positive physical parameters and vital signs for Astronaut Glenn after the flight are listed in table VIII.

The vital signs noted in table VIII were recorded during the postflight physical examination conducted onboard the destroyer. There were two small, superficial skin abrasions of the knuckles of the second and third fingers of the right hand, but these occurred without deformation or fracture. They were received when the explosive hatch actuator recoiled against the pilot's gloved hand. The skin also exhibited an area of moderate erythema (reddening) and a skin depression at the point where the left arm blood pressure microphone had been attached. There was also a mild reaction to the moleskin adhesive plaster which attached the four ECG electrodes. Results of the head, eye, ear, nose and throat examinations were normal. The heart rhythm, size, and sounds were normal, and the lungs were clear without physical evidence of atelectasis (local lung collapse). Results of the examination of the abdomen were normal, and the lower extremities showed no evidence of edema (swelling) nor venous thrombosis (clotting). The results of the general neurologic examination were also normal.

Blood and urine samples were obtained and processed for later analysis. Results available to date are listed in tables IX through XII.

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range stations and the continuous onboard recording. In addition, various inflight tests and the pilot-observer camera film were utilized for further objective analysis. Subjective evaluation included pilot reports from onboard voice and the total postflight debriefing. The countdown period provided baseline preflight information. Useful comparative measurements were available from the Mercury-Atlas three-orbital centrifuge simulation; and from the pad simulated launch, simulated flights, and the January 27 launch attempt. Environmental control system data were correlated with physiological responses were appropriate.

Bioinstrumentation: In addition to the sensors used for the manned Mercury-Redstone flights (two ECG leads, respiratory rate sensor, and body temperature sensor), a blood pressure measuring device was utilized in flight. The blood pressure apparatus consisted of a pneumatic nylon cuff placed on the left upper arm and a microphone located under the cuff over the brachial artery. To obtain the blood pressure, the cuff was inflated manually. The record consisted of the sound pulses superimposed on a cuff pressure decay curve. This record was displayed on the second ECG channel. Preflight and postflight calibrations of the blood pressure system showed no significant change.

The total biosensor monitoring time, from astronaut insertion until just prior to landing, was eight hours and thirty-three minutes.

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Approximately three hours after landing, the astronaut was transferred to the Aircraft Carrier U. S. S. Randolph where posterior-anterior and lateral chest X-rays, a standard 12-lead electrocardiogram reading, and body weight were obtained.

Later the astronaut flew to Grand Turk Island where a general physical examination was begun at 2130 hours e.s.t., approximately 6-3/4 hours after spacecraft landing. The vital signs at that time are included with the postflight values above. Except for the previously described superficial skin abrasions, the results of the entire examination were normal. During the subsequent 48 hours, comprehensive examinations were conducted by the medical specialists who examined the astronaut prior to flight. Special tests were performed in an effort to delineate any effect of space flight upon the astronaut's balance (inner ear) and no effect was detected. Both the general and the specialists' examinations revealed no significant changes. The medical studies were completed at 1400 e.s.t., February 22, 1962.

In summary, the preflight and postflight clinical studies revealed no significant differences and, except for the immediate postflight dehydration, were completely within normal limits.

Physiological studies.-

Data sources: Data reflecting physiological responses to flight were obtained by evaluating the biosensor real time recordings from

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The biosensor readout quality was excellent throughout the countdown and flight, with the exception of the respiratory trace. As in prior flights, variation with head position and air density combined to reduce the quality of the respiration trace. There were brief periods of noise on the ECG channels during countdown and flight, usually occurring during vigorous pilot activity.

Preflight: Figure 26 depicts the pulse rate, respiration rate, body temperature, suit inlet temperature, and blood pressure values recorded during the MA-6 countdown. Values for the physiological functions obtained from the simulated launch of January 19 and the launch attempt of January 27, 1962, are also shown. These are plotted coincident with significant events.

Minute pulse and respiration rates were determined by counting the rates for 30 seconds every 3 minutes until ten minutes prior to lift-off, and, thereafter, 30 second duration counts were made each minute. During approximately 45 minutes in the transfer van, the astronaut's pulse varied from 58-82 beats per minute, with a mean 72, and blood pressure was 122/77 mmHg. The pulse rates during the scrubbed flight countdown of January 27 varied from 60-88 beats/minute, with a mean of 70. These were essentially the same as those observed during the MA-6 countdown when the mean pulse was

68 beats/minute. Respiration rates were similar, varying from 12-20 breaths/minute. Blood pressure values from the simulated launch also approximated those observed during the MA-6 countdown. A pulse rate of 110 beats/minute and a blood pressure of 139/88 was observed at lift-off. The low suit inlet temperature maintained during countdown resulted in the pilot feeling cold, which was accompanied by a fall in body temperature from 98.6° at insertion to 97.6°F at lift-off.

An examination of the electrocardiographic waveform obtained during the MA-6 countdown revealed a number of variations in the pacemaker activity, which is the point where the stimulus of the heart beat originates. These included sinus pauses, sinus bradycardia (slowing), premature atrial and nodal beats, and premature ventricular beats. On several instances, some of these reported findings occurred with deep respiration. Similar findings were recorded from the simulated launch of January 19 and the scrubbed flight of January 27. In addition, a brief run (16 beats) of atrial rhythm with a rate of 100 beats/minute occurred during countdown, and an isolated run (19 beats) of a rhythm originating adjacent to the atrio-ventricular node with aberrant conduction occurred during the attempted launch of January 27. However, these were not observed at any other time. All of the above are not unexpected physiologic variations. Samples of MA-6 records taken at the time of insertion and at T-50 seconds are shown in figures 29 and 30 respectively.

Flight: Figure 31 depicts the inflight physiological data, and included values from the Mercury-Atlas, three-orbit centrifuge simulation are for comparison. Minute pulse rates were counted every 30 seconds during the MA-6 launch and reentry phases and for 30 seconds at three minute intervals throughout the orbital flight. Because of the variation in respiratory recording quality, rates were counted for 30 seconds whenever quality permitted, and these varied from 8 to 19 breaths/minute throughout flight.

The pulse rate from lift-off to spacecraft separation (powered flight phase) reached a maximum of 110 beats/minute. The pulse rate varied from 88 to 114 beats/minute during the first 10 minutes of weightlessness. It then remained relatively stable, with a mean rate of 86 beats/minute during the next 3 hours and 45 minutes of flight. At the time of retrorocket firing, the rate was 96 beats/minute. During reentry acceleration and parachute descent, the highest rate was 134 beats/minute just prior to drogue parachute deploy which was the period of maximum spacecraft oscillation. This rate was the highest noted during the mission. These rates suggest that acceleration, weightlessness, and return to gravity were within physiologically tolerable limits.

The ECG variations noted during the preflight observation period were not observed in flight, and analysis of the inflight record revealed only normal sinus rhythm with short periods of sinus bradycardia

and sinus arrhythmia (variation). There were rare periods when trace quality deteriorated to a point where only pulse rate determinations were possible. ECG variations noted during Astronaut Glenn's Mercury-Atlas, three-orbit centrifuge simulation included sinus arrhythmia, sinus bradycardia, atrial and nodal premature beats, and rare premature ventricular contractions. These are interpreted as being normal physiological variations.

Ten blood pressure determinations were made in flight, the first at 00:18:30 and the last at 03:14:00. Values as shown in figure 27 range from 119 to 143 mmHg systolic and from 60-81 mmHg diastolic. The mean blood-pressure values from various major blood pressure data sources are presented in the following table.

Data Sources	No. of determination	Mean Blood Pressure mmHg	Mean Pulse Pressure mmHg	Systolic Pulse Pressure, mmHg	Diastolic Range mmHg
Physical exams	14	110/66	44	98 to 128	60 to 80
Procedure trainer	15	121/76	45	110 to 132	66 to 87
3-orbit Mercury-Atlas centrifuge simulation	56	114/80	34	92 to 136	68 to 92
Launch-pad tests	26	104/76	28	91 to 125	64 to 91
MA-6 countdown	14	123/87	36	101 to 139	83 to 93
MA-6 flight	10	129/70	59	119 to 143	60 to 81

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The MA-6 inflight mean pulse pressure value shows some widening when compared with the centrifuge preflight values. The mean blood pressure value from static Procedures Trainer simulations was 120/73. The widened pulse pressure, which appeared after one hour of flight, is of uncertain physiological significance and more information is needed before conclusions can be reached. Samples of physiologic data from the onboard record are shown in figures 32 through 34.

The inflight exercise device is illustrated in figure 35. Exercise was accomplished by a series of pulls on the elastic bungee cords. An exercise period over Zanzibar during the first orbital pass raised the pilot's pulse rate from 80 to 124 beats/minute after 30 seconds. The pulse rate returned to 84 beats/minute within two minutes. The blood pressure before exercise was 129/76 mmHg and 129/74 after exercise, which is similar to procedures trainer values.

The environmental control system effectively supported the pilot throughout the mission. It should be noted, however, that body temperature gradually rose from a lift-off value of 97.6°F to 99.5°F at biosensor disconnect. The suit inlet temperature increased slowly during most of the flight, with a more rapid rise after reentry and during parachute descent. During and immediately following descent, the suit inlet temperature increased approximately 1°F/minute for a 15 minute period and probably contributed to the pilot's

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overheated status observed at egress. Since biosensor disconnect occurred 13 minutes before loss of signal, the maximum body temperature may not have been observed.

Pilot inflight observations: The astronaut's voice reports were consistently accurate, confident, and coherent through all phases of the flight. His voice quality conveyed a sense of continued well being. His mental state appeared entirely appropriate for the situation. The pilot's mood and level of performance was effectively conveyed by his voice reports. His prompt responses to ground transmissions and to sounds from the spacecraft suggest no decrement in hearing ability. Visual acuity was maintained, and his report of visual perceptions, especially with regard to colors, was confirmed as being accurate by the inflight photographs.

The pilot's voice report contained observations of physiological significance. During his postflight debriefing these reports were amplified. Those considered most significant are discussed below.

No disturbances in spatial orientation were reported, nor were any symptoms suggestive of vestibular (inner ear) disturbances described during the flight. Voluntary rapid head turning movements produced no unpleasant sensations. No sensory deprivation of "break-off phenomena" was noted.

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A brief sensation of tumbling forward occurred just after SECO, which was similar to that described by the astronauts in the MR-3 and MR-4 missions. This sensation ended promptly and was not associated with nausea. Coincident with retrorocket firing, a feeling of movement opposite from flight direction was noted. This could be expected with the sudden change in spacecraft velocity. The pilot noted no difference in the sensations associated with reentry accelerations from those experienced during launch.

Food chewing and swallowing was accomplished without difficulty. No water as such was ingested during flight.

The pilot urinated without difficulty shortly before reentry. He described "normal" sensations of bladder fullness with the associated urge to urinate.

The astronaut described weightlessness as a "pleasant" sensation. Control manipulation was not a problem, and there was no observable performance decrement. The restraint harness and couch combination was reported to be comfortable.

In summary, the MA-6 mission provided a period of extended weightlessness during which the astronaut's physiological responses apparently stabilized. The values attained were within ranges compatible with normal function. No subjective abnormalities were reported by the pilot.

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Conclusions.-

1. The physiological responses observed during the MA-6 mission are all consistent with intact, normal function.

2. Comparison of the preflight and postflight medical evaluations revealed no significant differences, and each was completely within normal limits with the exception of moderate dehydration.

3. The MA-6 mission provided an exposure to weightlessness of sufficient duration to permit physiological responses to reach a relatively steady state.

4. No symptoms reflecting disturbed vestibular function were reported. This lack of findings occurred even though specific attempts were made to stimulate the vestibular organ in flight.

5. Four hours and thirty-eight minutes of weightlessness were tolerated without observable performance decrement.

6. The pilot's subjective evaluation of his body processes and sensations during the flight all conveyed normal function.

7. Acceleration-weightlessness transition periods did not produce any recognized physiological deterioration. Specifically, reentry acceleration after 4 hours and 38 minutes of weightlessness did not produce any unexpected symptoms, and physiological data remained within functional limits.

8. The environmental control system effectively supported the pilot throughout the mission.

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9. The astronaut's apparent fatigue noted in the immediate post-flight evaluation can be attributed to a number of factors. The most logical explanation is the dehydration following overheating plus the cumulative effects of the various stresses experienced in the pre- and inflight periods.

10. His mild gastrointestinal discomfort which occurred after landing may likewise be attributed to the increased environmental temperature and moderate dehydration of the astronaut. The motion of the spacecraft on the sea may be a contributory factor. This sensation cleared after a brief period of rest and rehydration.

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TABLE VII.- SIGNIFICANT EVENTS PRIOR TO LAUNCH

Date	Time ¹	Event
February 19, 1962	2130	Retired
February 20, 1962	0220	Awakened and showered
	0250	Breakfast
	0305	Physical examination
	0428	Suiting started
	0505	Entered transfer van
	0520	Arrived at Pad 14 and remained in transfer van
	0558	Ascended gantry
	0606	Insertion
	0625	Countdown resumed
	0947	Launch

¹All times e.s.t.

TABLE VIII.- PRE- AND POSTFLIGHT PHYSICAL PARAMETERS OF THE ASTRONAUT

<u>Variables</u>	<u>Preflight</u>	<u>Postflight</u>
General status	Eager for flight	Alert, but not talkative; sweating profusely; appeared fatigued; not hungry.
Weight	171 7/16 pounds at 0315 hours ¹	166 2/16 pounds at 1850 hours
Temperature	98.2°F (oral)	99.2°F (rectal at 1600 hours) 98°F (oral at 2400 hours)
Respiration	14	14
Pulse	68	76 (shipboard); 72 (Grand Turk)
Blood pressure	118/80 (sitting)	105/60 (standing) and 120/60 (supine) at 1545 hours 128/68 (sitting) at 2130 hours
Heart and lungs	Normal	Normal - no change
Skin	No erythema or abrasions	Erythema or biosensor sites; superficial abrasions second and third fingers of right hand.
Extremity measurements, inches		
Wrist		
Left	6 7/8"	6 3/4"
Right	7"	7"
Calf (max)		
Left	16 7/8"	16 5/8"
Right	16 1/2"	16 1/8"
Ankle (min)		
Left	9 3/8"	9"
Right	9 1/8"	9 1/4"

¹All times e.s.t.

TABLE IX.- PERIPHERAL BLOOD

	Preflight				Postflight		
	Mar. 1959	Aug. 1960	Aug. 1961	-29 days ¹	-8 days ¹	+8 h ¹	+46 hr ¹
Hematocrit, percent	45	45	42	-----	39.5	46	42
Hemoglobin (Cyanmethemoglobin method), grams/100 ml-	15.7	15.3	13.6	14.5	14.1	16.1	14.7
Red blood cells X 10 ⁶ /mm ³ -----	-----	-----	-----	4.75	4.96	4.82	5.03
White blood cells/mm ³ -----	5, 000	5, 000	6, 310	5, 100	4, 650	8, 200	5, 450
Differential white-blood count:							
Lymphocytes, percent-----	40	41	45	37	47	36	33
Neutrophils, percent-----	58	49	42	57	47	58	57
Monocytes, percent-----	1	6	7	3	3	3	3
Eosinophiles, percent-----	1	4	5	1	2	2	5
Basophiles, percent-----	1	0	1	2	1	1	2

¹Determinations by same technician.

TABLE X.- BLOOD SUMMARY¹

	Centrifuge			MA-6 flight				
	Prerun	Postrun		Preflight		Postflight		
		+2 hr	+6 hr	-29 days	-8 days	+1 hr	+8 hr	+46 hr
Glucose (whole blood) mgm/100 ml	97	112	121	95	109	---	96	99
Sodium (serum), mEq/L-----	143	140	154	155	160	146	144	143
Potassium (serum), mEq/L-----	4.8	4.8	5.6	5.4	4.6	3.9	4.4	4.4
Calcium (serum), mEq/L-----	5.2	6.0	5.2	4.9	4.3	4.3	4.2	4.4
Chloride (serum), mEq/L-----	80	83	83	95	98	104	104	104
Protein (total serum), g/100 ml-	7.9	7.7	8.0	6.9	6.6	6.9	6.6	6.7
Albumin (serum), g/100 ml-----	4.3	4.1	4.7	4.1	3.8	3.8	3.8	3.8
Albumin/Globulin ratio (serum)--	1.2	1.1	1.2	1.4	1.4	1.2	1.4	1.3
Urea Nitrogen (serum) mg/100 ml-	15.4	16.0	14.3	14.1	15.5	10.5	10.5	11.6
Ephinephrine, plasma µg/L-----	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Norepinephrine, plasma µg/L-----	0.1	0.1	0.1	5.1	18.1	---	6.0	3.8

¹Operational priorities precluded making a biochemical requirement for fasting specimens.

TABLE XI.- PLASMA ENZYMES SUMMARY

	Normal values	Centrifuge				MR-3 backup	MR-4 backup	MA-6 flight			
		Prerun	Postrun +6 hr	Prerun	Postrun +2 hr			Pre-flight	Postflight		
									+1 hr	+8 hr	+46 hr
Transaminases:											
SGOT-----	0 to 35	19	27	68	62	33	48	18	33	27	23
SGPT-----	0 to 20	6	10	50	50	10	4	---	---	---	---
Esterase:											
Acetylcholine-----	130 to 260	165	185	---	---	250	220	240	305	245	275
Peptidase:											
Leucylamino-----	100 to 310	220	250	350	350	380	370	300	250	290	255
Lecucylamino, heat-stable	-----	---	---	250	150	---	---	---	---	---	---
Aldolase-----	50 to 150	25	---	50	40	41	13	112	90	209	120
Aldolase, heat treated	0	---	---	---	---	---	---	22	40	35	25
Isomerase:											
Phosphohexase-----	10 to 20	10	9	30	51	13	23	0	24	22	9
Dehydrogenases:											
Lactic-----	150 to 250	190	125	560	860	250	235	265	220	390	250
Lactic, heat stable-----	-----	---	---	375	595	---	---	95	60	95	85
Percent residual-----	14 to 15	---	---	---	---	---	---	39.6	19.7	38.7	30.9
Malic-----	150 to 250	250	---	530	905	225	280	---	---	---	---
Malic heat stable-----	-----	---	---	330	420	---	---	---	---	---	---
Succinic-----	0	0	0	0	0	0	0	---	---	---	---
Inosine-----	0	0	0	22	15	5	3	---	---	---	---
Alpha-ketoglutaric--	0	0	0	---	---	---	---	---	---	---	---
Beta-glutamic-----	0	0	0	---	---	10	---	---	---	---	---
Phosphatase:											
Alkaline-----	10 to 20	---	---	11	0	8	5	---	---	---	---
Lactic Acid-----	-----	---	---	---	---	---	---	36	185	88	55
Cholesterol-----	-----	---	---	---	---	---	---	197	---	---	185
Cholesterol esters, percent-----	-----	---	---	---	---	---	---	70	---	---	71
DPNH Oxidation (non-specific enzyme activity)-----	0	---	---	---	---	---	---	26	65	92	46

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Astronaut Activities

This section presents a brief review of the astronaut's activities in preparation for and during the MA-6 mission.

Preflight training summary.-

Spacecraft checkout activities: Astronaut Glenn's involvement in the preflight checkouts provided him with the opportunity to become thoroughly familiar with the MA-6 spacecraft and launch vehicle systems. Table XIII summarizes his checkout activities. He spent 23 hours and 55 minutes in the spacecraft itself, and many more hours were consumed before and after each pad checkout operation in preparation, trouble-shooting, observation, and discussion.

Training activities: Table XIV is a brief summary of the training activities using the procedures trainer from December 13, 1961, to February 17, 1962. During this period, the astronaut spent 59 hours and 45 minutes accomplishing 70 simulated missions and experiencing 189 simulated systems failures. The main emphasis during this period was on procedural training, particularly launch and early mission failures usually calling for an aborted mission. Glenn also accomplished several three-pass missions on the trainer, as well as several simulations involving the MCC, the blockhouse, and the entire Mercury Network. The astronaut also spent a great deal of time in briefings on the various subsystems and flight planning and in individual study.

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Flight preparedness: Astronaut Glenn achieved a high level of skill and knowledge several weeks prior to the actual launch date. There was a gradual reduction in the intensity of the preflight training program, particularly on the procedures trainer. Nevertheless, there was no decline in his level of preparedness, as demonstrated in part by figure 36, which shows his sustained effectiveness in retrofire practice. Astronaut Glenn's comments during postflight debriefing sessions recognizes the value of his preflight training. His major comments were (1) that his participation in the spacecraft checkouts was very useful, (2) that personal briefings from systems experts were helpful, and (3) that the ALFA trainer was less valuable than the procedures trainer as an attitude control trainer.

Chronology of pilot's activities during flight.-- Figure 37 is a simplified chronology of the pilot's activities during the MA-6 flight from lift-off to landing. Identification of continental limits, certain celestial observations, photography, and communications modes are not included in the table, since the communications tapes do not provide sufficient time correlation. Spacecraft systems problems during the flight prevented the pilot from completing all the tasks in the MA-6 flight plan. These problems also interfered with his providing a complete running commentary on those he did complete.

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Attitude control.- The pilot's attitude control activities are summarized in table XV. The pilot was able to control the vehicle adequately throughout the flight with the exception of the last portion of reentry. The general ability of the pilot to control the vehicle is illustrated by the brief review of the major manual maneuvers discussed below.

Control systems check: The control systems check is designed to check all of the primary control modes in a minimum amount of time and with minimal fuel usage. This series of maneuvers was accomplished smoothly and efficiently, and was almost identical to the performance on the procedures trainer prior to the flight. The attitudes achieved varied less than 10 degrees and the rates did not vary over 1/2 degree per second from the procedures trainer simulation at any time.

60° right-yaw maneuver: The astronaut performed this smoothly, overshooting only three or four degrees, which is within the accuracy of his visual abilities to determine the exact 60° position on his indicator (see figure 38).

Three 180° right-yaw maneuvers: The first 180° maneuver, using the window as the primary attitude reference, was intended as a precise 180° maneuver, keeping the pitch and roll errors minimized. The

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second and third yaw maneuvers were done only for the purpose of observing and taking pictures of the sunrise and the particles surrounding his spacecraft. These maneuvers were accomplished satisfactorily as can be seen in figure 39.

Holding on constellation: The astronaut held on the constellation Orion on two different occasions during the flight. Figure 40 illustrates the attitude variations during the second period on Orion. These variations are within the limits normally held on instruments on the ALFA and Procedures Trainers.

Gyro caging: The astronaut caged and uncaged the gyros immediately after completion of each of the three 180° yaw maneuvers because of disagreement between indicated and true attitude. The third caging occurred shortly before the second sunrise while still on the dark side of the earth; the other two cagings were performed during the daylight periods. The records indicate that he uncaged at approximately zero yaw and roll and a minus 14 degrees in pitch for both day operations, but that he caged and uncaged at zero yaw, minus 14 degrees pitch, and a minus 20 degrees in roll during the night-side operation. It is unlikely that the pilot would have been able to align the spacecraft so well in yaw and yet make an error in roll which should be easier to determine using the window. It therefore seems likely that the astronaut's attention was diverted by other duties. The pilot caged and uncaged the gyros at a -14° in pitch,

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even though he reported to the ground that he was going to zero, zero, zero attitude during the first caging operation. Caging at a -14° in pitch, using the window reference, is necessary to see the horizon. The astronaut's report to the ground was a communication error.

Retrofire control: The astronaut backed up the ASCS during the retrosequence and retrofire events using the manual proportional control mode. It is impossible to assess individually the operations of the ASCS or of the astronaut at this time. The attitudes did not deviate more than ± 3 degrees during this event.

Reentry pitch maneuver: Astronaut Glenn used the manual proportional control system and the rate and attitude indicators to pitch to the reentry attitude. As can be seen from figure 41 he performed this maneuver with precision and was well within his capability demonstrated on ground trainers.

Reentry damping: The early part of the reentry through peak deceleration (max. g) was controlled by employing fly-by-wire and manual proportional systems. The oscillations were small during the early part of reentry prior to max. g (see figure 42). After 04:47:00, the pitch and yaw oscillations built up rapidly and the pilot's stick inputs did not result in satisfactory control. From analysis of the fuel usage, his manual fuel was depleted at 4:47:04.

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The fly-by-wire control mode apparently still had fuel available, as indicated by the effectiveness of the Auxiliary Damping System at 04:47:42. The lack of satisfactory control was due to the change in control effectiveness because of depletion of manual fuel.

Pilot's use of external reference: The pilot reported that, in general, he was able to orient the vehicle, using external reference without difficulty, particularly in the roll and pitch axes. The pilot stated that there was a period of learning to use the periscope and the window as a yaw reference; however, he felt that by the end of the flight he was able, on the daylight side, to adjust yaw within a few degrees. During the flight he developed the procedure of pitching down to -60° in pitch in order to be better able to pick up terrain drift due to the orbital velocity. At a pitch attitude of -34° , apparent velocity of terrain movement is $.60^{\circ}$ per second, whereas at -60° pitch attitude the apparent velocity due to orbital movement is 1.41° per second. The greater apparent drift as the vehicle pitches toward the nadir point aids yaw determination by increasing the ratio of the terrain movement due to orbital rate in comparison to apparent terrain movement due to spacecraft attitude rate. The pilot did not like the periscope as well as the window for yaw alignment. He did not like the periscope high-magnification view because of the unclear area at the border between the high- and low-magnification views. The astronaut reported that

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he felt that going forward was the "best way to travel", "just like sitting up in front of a Greyhound bus watching the world come at you."

On the night side, the pilot reported that the horizon was always visible through the window. With full moon illumination he felt that he could align the spacecraft in yaw almost as well as on the daylight side. Glenn was not able to use the eye patch to dark-adapt; therefore, he was able to see little, if anything, of the ground or clouds before moonrise. With good dark-adaptation and lower cabin illumination, it well may be possible to see clouds even without the moon, since a fair amount of illumination will be provided from other night light phenomena. In general, the pilot reported that the periscope was not very useful for determining drift on the night side. Even with a full moon, the clouds were too dim in the periscope to pick up a specific point and follow it for yaw heading information.

The pilot reported that he could use star drift as a reference at yaw angle close to 90°, but that within ten degrees of zero yaw, it was quite difficult. The pilot was also able to use constellations as a heading reference. He reported that the number of stars that he could see were approximately the same as normally can be seen from the ground on a dark night. He had no trouble recognizing constellations and therefore could use the stars to determine heading by referring to his Star Navigation Device.

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Communication Activities.- Table XVI summarizes the flight communications. The pilot reported that he felt more time was devoted to formal operational reports during the MA-6 mission than would be desirable for future flights. Reduction of the high proportion of communications involved in making radio contact, reporting switch positions, and relaying instrument readings would permit more detailed reports by the pilot of his activities and observations.

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Scientific Observations.-

Celestial Observations: Numerous small particles of $1/16$ " to $3/8$ " in size were observed during each sunrise period as moving rearward past the spacecraft at a relative velocity estimated at 1.3 to 2.2 meters per second. Since some of the particles were seen to drift into the spacecraft's shadow, the estimated sizes and the velocities can be relied upon. The small difference in the relative velocity between the spacecraft and the particles indicates nearly the same orbit, which makes it certain that the particles came from the spacecraft. They undoubtedly drifted due to some aerodynamic drag. The most plausible material for the particles is frozen water, since other substances are either not present in sufficient quantities, or are limited in source, which ought to be exhausted by the third orbital pass. Water from the spacecraft environmental control system is more slightly probable than from the thrusters, because of the low observed velocities. This supply is sufficient and frozen water is consistent with the observed colors and movements.

A luminous band observed around the horizon may be the result of internal reflections of the moonlit earth between two inclined windows in the spacecraft. This explanation has been strengthened by observation of the band in earth photos from the spacecraft, by

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calculation from the blueprints, and by direct observation in the trainer and in spacecraft 18. The tan to buff color is found in one of ten observed reflections. If not a reflection, the pilot may have seen the 6300 and 6464 A° red layer which is known to exist at about the altitude reported.

The sun was observed to be highly flattened on some sunset photographs, although the phenomenon was not reported visually. Spectra of half a dozen stars in Orion were obtained with a hand-held, objective-prism spectrograph.

Meteorological observations: U. S. Weather Bureau Scientists suggested a program of observations for the astronaut which was designed to provide information for the development of improved optical sensing equipment for satellite weather-observation systems. Three of the requested observations reported by Glenn are listed below.

1. Determine whether cloud heights can be evaluated from orbital altitude. Report: The astronaut reported he could identify cloud types and determine cloud heights.

2. Determine whether clouds can be seen on the dark side of the earth. Report: The pilot reported that with the full moon up he was able to see clouds on the dark side and some vertical development.

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3. Determine whether lightning can be seen on the dark side of the earth. Report: Astronaut Glenn reported that he could clearly see lightning in two storms in the Indian Ocean, which were flown over in the night time.

The Weather Bureau also suggested that pictures, using infra-red film and a special set of filters, be taken of cloud cover in order to evaluate the relative effectiveness of various wave length intervals for cloud observation. The required filter and film was aboard the MA-6 flight spacecraft. However, this was scheduled for the third pass and because of the RCS malfunction the pilot was not able to carry out this exercise.

Terrestrial Observations: It is important to learn what the effective visual horizon for the pilot in orbital space may be and at what distance he can recognize landmarks for use in navigation and attitude control. The pilot's observations for the MA-6 flight are summarized in the following paragraphs.

Astronaut Glenn confirmed what earlier earth-sky pictures and Tyros photographs have indicated, namely that a large percentage of the earth's surface is covered by clouds. Only four land areas, the western African desert, western Australia, the western United States, and the eastern coast of the United States, were relatively free of clouds during the four and a half hours of the MA-6 flight.

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Glenn reported that he could see the following landmarks during the daylight periods across the United States: the cities of El Paso, New Orleans, Charleston, and Savannah; the Salton Sea in California, the Mississippi Delta, and Cape Canaveral. He also reported a V-shaped figure in the water in the Atlantic, which he interpreted to be a wake from a ship. This is probably the smallest object reported by the pilot. If it was the wake of a destroyer, the wake would be approximately 120 feet in width and perhaps 300 yards long.

The only non-illuminated feature seen at night, other than clouds, was a faint indication of the western coastline of Australia. Two types of illuminated features were reported, lightning produced by two storms in the Indian Ocean and the lights of the City of Perth. The Indian Ocean Ship flare was not seen, undoubtedly because of cloud cover.

Color Photographs: The pilot was able to take a total of seventy photographs, thirty-eight of which were on one roll and the balance on a second. Table XVII contains a complete listing of the subjects and the approximate times of exposure. The pilot attempted to take pictures of the particles seen during sunrise using the color film. While there are several photographs containing specks, it cannot be definitely determined that these specks are actually the particles observed.

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Orientation and Sensations During Weightlessness.-

General Sensations: The pilot reported that weightlessness was not unpleasant, no problem at all, and that in several respects it was easier or more enjoyable than the 1g condition. For example, there were no pressure points from the seat, and certain tasks were easier such as using the camera and other personal equipment. This equipment could be left hanging in midair while another task was performed.

Of operational significance was his report that, under weightlessness, the head assumes a new position due to the helmet tie-down straps. This suggests that the visual angles through the window and the periscope would be slightly different.

The pilot reported no problem in reaching for and activating controls. There was no tendency to overreach. This was not unexpected, since experience has shown that the eyes will quickly correct for muscular reaction inaccuracies. A more positive demonstration of psychomotor adjustment to weightless conditions would be by demonstrating capability to locate areas in the spacecraft with the eyes closed.

Russian Astronaut Titov reported¹ vertigo and nausea by the sixth orbital pass under three conditions, when the heat was rotated, when he tracked rapidly moving objects, and when he

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tapering very slowly toward the horizon. I could not pick up any appreciable Zodiacal light. I looked for it closely; I think perhaps I was not enough night adapted to see it. Sunrise, I picked up in the periscope. At every sunrise, I saw little specks, brilliant specks, floating around outside the capsule. I had no idea what they were. On the third orbit, I turned around at sunrise so that I could face into the sun and see if they were still heading in the same direction and they were. But I noticed them every sunrise and tried to get pictures of them.

Just as I came over Mexico at the end of the first orbit, I had my first indication of the ASCS problem that was to stick with me for the rest of the flight. It started out with the yaw rate going off at about one and one-half degrees per second to the right. The capsule would not stay in orbit mode, but would go out of limits. When it reached about 20° instead of the 30° I expected, it would kick back into orientation mode and swing back with the rate going over into the left yaw to correct back to its normal orbit attitude. Sometimes, it would cross-couple into pitch and roll and we'd go through a general disruption or orbit mode until it settled down into orbit attitude. The yaw would again start a slow drift to the right and the ASCS would kick out again into orientation mode. I took over manually at that point and from then on, through the rest

attempted to reach switches which required head and body movements. Glenn reported that he repeated these same activities at approximately half-hour intervals throughout the flight, beginning cautiously with very slow head movements and proceeding to more rapid and vigorous motions as time progressed. He reported there was no difference in sensation between zero g and 1g. The difference between Glenn's and Titov's experiences can be logically explained by either or both of two factors. First, Titov's symptoms appeared after approximately twice the weightless period that Glenn experienced, and, secondly, Titov may be physiologically more sensitive to certain effects of weightlessness than Glenn.

Orientation: John Glenn reported that he experienced two illusions of motion, but both of these were associated with changing acceleration fields and not with zero g per se. The first occurred at SECO, when he felt as if he were slightly pitching forward head over heels. The second illusion of motion occurred during retro-rocket firing, at which time he reported that he felt like he was going back towards Hawaii. He stated that following retrofire, when he was able to look out the window and see the terrain moving away from him, this illusion disappeared.

¹Some results of physiological reactions to space flight conditions, by O. G. Gzenko, USSR, Academy of Sciences, Moscow.

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No illusions of position occurred during zero g. Glenn did not feel at any time that he was standing still and the earth was moving, or that he was in any position other than the true spacecraft position during the flight.

The pilot reported that he could feel accelerations which produced rates above 5 degrees per second. This is approximately in agreement with the tests on the pilot conducted at Pensacola on the Human Disorientation Device (a two dimensional rotational apparatus). There is no indication of greater sensitivity to rotational forces under zero g than 1g, however, the observations are too limited to warrant firm conclusion.

A final area of interest was his judgement of vertical and horizontal during weightlessness. Normally, this perception is strongly affected by the otolith organs of the inner ear. Variations in the ability to determine the horizontal have been demonstrated when the individual is asked to adjust a visible line in a completely dark room while lying on his side. Errors in this adjustment usually occur after approximately two minutes with the lights out. Provisions for conducting this test have been built into the miniaturized photometer carried aboard the spacecraft. The pilot's adjustment to the horizontal was accurate. However, interpretation of the results is difficult since, because of the control problem, the pilot was rushed and made the line adjustment very shortly after looking into the device.

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Personal Equipment.- The equipment that the pilot used and his relevant comments are presented in this section.

The daylight color camera: (See figure 43). A 35mm Ansco Autoset with a photoelectric cell to automatically adjust the F stop was provided. It has a 50mm, F2.8 lens and has been provided with controls permitting rapid one-hand operation. The only comment regarding camera operation concerned changing film. He released the cassette, and, in reaching for it, it got away and floated behind the instrument panel. The results of the efforts with this camera are in the section labeled Photographic Efforts.

Ultra-violet spectrograph: (See figure 44). A Leica 35mm camera with a special lens system adapted for ultra-violet spectral photography was included. The results of this experiment are contained in the section on Astronomical Observations.

Photometer: (See figure 45). This is a miniature device used by the pilot to view the sun at sunset and to evaluate his capability to orient to the horizontal.

Air glow filter: (See figure 46). This device filtered all light except the 5577 line. The only attempt to use this filter produced no results. This is primarily because of a low level night adaptation at the time.

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Night adaptation eye patch: (See figure 47). The form-fitted mold which is attached with tape prior to sunset, worked well prior to lift-off but failed to remain positioned during the flight. The combined effects of minute dust in the spacecraft, low humidity, and perspiration of the astronaut undoubtedly reduced the effectiveness of the adhesive.

Map booklet and star navigation device: The location of these devices was reported as having been awkward.

Flight plan cards: These are similar in style to figure 37 and three cards were provided to aid in maintaining schedules and to serve as a reminder of upcoming events.

Food Tube: (See figure 48). Two tubes were provided, one containing beef and vegetables and the other applesauce. He consumed the applesauce without difficulty, but did not have an opportunity to open the other tube.

Food Tablets: (See figure 49). A food tablet dispenser was provided containing one xylose tablet and several malt tablets.

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TABLE XIII.- TIME EXPENDED IN ASTRONAUT PRELAUNCH ACTIVITIES

DATE	ACTIVITY	DURATION ¹ , HRS :MIN
January 15	Flight Acceptance Composite Test	7:45
January 17	Launch simulation	5:10
January 19	Launch simulation	4:15
January 20	Simulated flight	1:30
January 23	Simulated flight	2:00
January 27	Countdown	4:00
January 29	Simulated flight	1:15
TOTAL TIME -		25:55

Time does not include allowance for preparation, monitoring, debriefing, trouble shooting, conferences, and the like.

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BRIEF SUMMARY OF MA-6 ORBITAL FLIGHT BY ASTRONAUT GLENN¹

There are many things that are so impressive, it's almost impossible to try and describe the sensations that I had during the flight. I think the thing that stands out more particularly than anything else right at the moment is the reentry during the fireball. I left the shutters open specifically so I could watch it. It got a brilliant orange color; it was never too blinding. The retropack was still aboard and shortly after reentry began, it started to break up in big chunks. One of the straps came off and came around across the window. There were large flaming pieces of the retropack - I assume that's what they were - that broke off and came tumbling around the sides of the capsule. I could see them going on back behind me then and making little smoke trails. I could also see a long trail of what probably was ablation material ending in a small bright spot similar to that in the pictures out of the window taken during the MA-5 flight. I saw the same spot back there and I could see it move back and forth as the capsule oscillated slightly. Yes, I think the reentry was probably the most impressive part of the flight.

¹This extemporaneous report by Astronaut John H. Glenn, Jr., was recorded onboard the Destroyer Noa shortly after the MA-6 mission on February 20, 1962 and is presented with superficial editing only.

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Starting back with highlights of the flight: Insertion was normal this morning except for the delays that were occasioned by hatch-bolt trouble and by the microphone fitting breaking off in my helmet. The weather cleared up nicely and after only moderate delays, we got off.

Lift-off was just about as I had expected. There was some vibration. Coming up off the pad, the roll programing was very noticeable as the spacecraft swung around to the proper azimuth. There also was no doubt about when the pitch programing started. There was some vibration at lift-off from the pad. It smoothed out just moderately; never did get to very smooth flight until we were through the high q area. At this time - I would guess a minute and fifteen to twenty seconds - it was very noticeable. After this, it really smoothed out and by a minute and a half, or about the time cabin pressure sealed off, it was smooth as could be.

The staging was normal, though I had expected a more sharp cutoff. It felt as though the g ramped down for maybe half a second. For some reason, it was not as abrupt as I had anticipated it might be. The accelerometers read one and a quarter g's when I received a confirmation on staging from the Capsule Communicator.

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I had been waiting for this message at that point because I was set to go to tower jettison as we had planned, in case the booster had not staged. At this time, I also saw a wisp of smoke and I thought perhaps the tower had jettisoned early.

The tower really had not jettisoned at that time and did jettison on schedule at 2+34. As the booster and capsule pitched over and the tower jettisoned, I had a first glimpse of the horizon; it was a beautiful sight, looking eastward across the Atlantic.

Toward the last part of the insertion, the vibration began building up again. This I hadn't quite expected; it wasn't too rough but it was noticeable. Cutoff was very good; the capsule acted just as it was supposed to. The ASCS damped and turned the spacecraft around. As we were completing the turnaround, I glanced out of the window and the booster was right there in front of me. It looked as though it wasn't more than a hundred yards away. The small end of the booster was pointing toward the northeast and I saw it a number of times from then on for about the next seven or eight minutes as it slowly went below my altitude and moved farther away. That was very impressive.

I think I was really surprised at the ease with which the controls check went. It was almost just like making the controls check on the Procedures Trainer that we've done so many times. The control check

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went off like clockwork; there was no problem at all. Everything damped when it should damp and control was easy. Zero-g was noticeable at SECO. I had a very slight sensation of tumbling forward head-over-heels. It was very slight; not as pronounced an effect as we experience on the centrifuge. During turnaround, I had no sensation of angular acceleration. I acclimated to weightlessness in just a matter of seconds; it was very surprising. I was reaching for switches and doing things and having no problem. I didn't at any time notice any tendency to overshoot a switch. It seemed it's just natural to acclimate to this new condition. It was very comfortable. Under the weightless condition, the head seemed to be a little farther out of the couch which made it a little easier to see the window, though I could not get up quite as near to the window as I thought I might.

The rest of the first orbit went pretty much as planned, with reports to the stations coming up on schedule. I was a little behind at a couple of points but most of the things were going right according to schedule, including remaining on the automatic control system for optimum radar and communications tracking. Sunset from this altitude is tremendous. I had never seen anything like this and it was a truly beautiful, beautiful sight. The speed at which the sun goes down is very remarkable, of course. The brilliant orange and blue layers spread out probably 45° to 60° each side of the sun

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of the flight, this was my main concern. I tried to pick up the flight plan again at a few points and I accomplished a few more things on it, but I'm afraid most of the flight time beyond that point was taken up with checking the various modes of the ASCS. I did have full control in fly-by-wire and later on during the flight, the yaw problem switched from left to right. It acted exactly the same, except it would drift off to the left instead of the right. It appeared also that any time I was on manual control and would be drifting away from regular orbit attitude for any appreciable period of time that the attitude indications would then be off when I came back to orbit attitude. I called out some of these and I remember that at one time, roll was off 30° , yaw was off 35° , and pitch was off 76° . These were considerable errors and I have no explanation for them at this time. I could control on fly-by-wire and manual very adequately. It was not difficult at all. Fly-by-wire was by far the most accurate means of control, even though I didn't have accurate control in yaw at all times.

Retrorockets were fired right on schedule just off California and it was surprising coming out of the zero-g field that the retro-rockets firing as though I were accelerating in the other direction back toward Hawaii. However, after retrofire was completed when I could glance out of the window again, it was easy to tell, of course, which way I was going, even though my sensations during

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retrofire had been that I was going in the other direction. I made retrofire on automatic control. Apparently, the solid-on period for slaving just prior to retrofire brought the gyros back up to orbit attitude, because they corrected very nicely during that period. The spacecraft was just about in orbit attitude as I could see it from the window and through the periscope just prior to retrofire. So, I feel that we were right in attitude. I left it on ASCS and backed up manually and worked right along with the ASCS during retrofire. I think the retroattitude held almost exactly on and I would guess that we were never more than 3° off in any axis at any time during retrofire.

Following retrofire, a decision was made to have me reenter with the retropackage still on because of the uncertainty as to whether the landing bag had been extended. I don't know all the reasons yet for that particular decision, but I assume that it had been pretty well thought out and it obviously was. I punched up .05g manually at a little after the time it was given to me. I was actually in a small g-field at the time I pushed up .05g and it went green and I began to get noise, or what sounded like small things brushing against the capsule. I began to get this very shortly after .05g and this noise kept increasing. Well before we got into the really heavy fireball area, one strap swung around and hung down over the window. There was some smoke. I don't know whether

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the bolt fired at the center of the pack or what happened. The capsule kept on its course. I didn't get too far off of reentry attitude. I went to manual control for reentry after the retros fired and had no trouble controlling reentry attitude through the high-g area. Communications blackout started a little bit before the fireball. The fireball was very intense. I left the shutters open the whole time and observed it and it got to be a very, very bright orange color. There were large flaming pieces of what I assume was the retropackage breaking off and going back behind the capsule. This was of some concern, because I wasn't sure of what it was. I had visions of them possibly being chunks of heat shield breaking off, but it turned out it was not that.

The oscillations that built up after peak-g were more than I could control with the manual system. I was damping okay and it just plain overpowered me and I could not do anymore about it. I switched to Aux. Damp as soon as I could raise my arm up after the g-pulse to help damp and this did help some. However, even on Aux. Damp, the capsule was swinging back and forth very rapidly and the oscillations were divergent as we descended to about 35,000 feet. At this point, I elected to try to put the drogue out manually, even though it was high, because I was afraid we were going to get over to such an attitude that the capsule might actually be going

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small end down during part of the flight if the oscillations kept going the way they were. And just as I was reaching up to pull out the drogue on manual, it came out by itself. The drogue did straighten the capsule out in good shape. I believe the altitude was somewhere between 30,000 and 35,000 at that point.

I came on down; the snorkels, I believe, came out at about 16,000 or 17,000. The periscope came out. There was so much smoke and dirt on the windshield that it was somewhat difficult to see. Every time I came around to the sun - for I had established my roll rate on manual - it was virtually impossible to see anything out through the window.

The capsule was very stable when the antenna section jettisoned. I could see the whole recovery system just lined up in one big line as it came out. It unreeled and blossomed normally; all the panels and visors looked good. I was going through my landing checkoff list when the Capsule Communicator called to remind me to deploy the landing bag. I flipped the switch to auto immediately and the green light came on and I felt the bag release. I was able to watch the water coming towards me in the periscope. I was able to estimate very closely when I would hit the water. The impact bag was a heavier shock than I had expected, but it did not bother me.

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Communications with the recovery ship Noa were very good. The Noa had me in sight before impact and estimated 20 minutes to recovery which turned out to be about right. When the destroyer came along-side, they hooked on with the shepherd's hook and cut the HF antenna. During capsule pickup, I received one good solid bump on the side of the ship as it rolled. Once on deck I took the left hand panel loose and started to disconnect the suit hose in order to hook up the hose extension prior to egressing through the upper hatch. By this time I was really hot - pouring sweat. The capsule was very hot after reentry and I really noticed the increase in humidity after the snorkels opened. I decided that the best thing at that point was to come out the side rather than through the top. I am sure I could have come out the top if I had had to, but I did not see any reason to keep working to come out the top. So I called ship and asked them to clear the area outside the hatch. When I received word that the area was clear, I removed the capsule pin and hit the plunger with the back of my hand. It sprung back and cut my knuckles slightly through the glove. The noise of the hatch report was good and loud but not uncomfortable.

In summary, my condition is excellent. I am in good shape; no problems at all. The ASCS problems were the biggest I encountered on the flight. Weightlessness was no problem. I think the fact

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that I could take over and show that a pilot can control the capsule manually, using the different control modes, satisfied me most. The greatest dissatisfaction I think I feel was the fact that I did not get to accomplish all the other things that I wanted to do. The ASCS problem overrode everything else.

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FLIGHT CONTROL AND NETWORK PERFORMANCE

The Mercury Network consists of the Mercury Control Center (MCC) at Cape Canaveral (CNV); stations at the Atlantic Missile Range (AMR), Bermuda (BDA), and at fourteen other locations along the orbital ground track; and communications and computing centers at the Goddard Space Flight Center. The Network affords a data acquisition capability for real-time monitoring, mission control, and postflight analysis. This section describes the flight monitoring and control and presents information on the performance of the communications, telemetry, tracking, computing, and command systems.

Flight Control Summary

The orbital launch and insertion parameters very closely approximated nominal conditions. The pilot's performance throughout the flight was excellent, and he was able to cope with the unusual situations which arose. Several problems developed in the spacecraft automatic control system. The ASCS system was unable to maintain the spacecraft within the preset attitude limits about the yaw axis after approximately one orbital pass because of the lack of thrust from the 1-pound yaw thrusters. This same malfunction was reflected in the system's operation when the astronaut selected the fly-by-wire mode however, he was able to maintain satisfactory attitude control about the yaw axis by using the larger thrusters. The horizon scanner and gyro reference system appeared to be in error mainly in the roll axis while the spacecraft was on the dark side of the earth.

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The manual-proportional control system worked well throughout the flight. The cooling system for both main inverters appeared to be inoperative throughout the entire flight and the inverter temperatures reached values as high as 210 to 220°F however, no inverter malfunctions occurred.

On the first pass over Canaveral, segment 51 of the commutator showed a signal indication which, if correct, indicated that the spacecraft heat shield had been deployed. Considerable analysis and discussion followed, and a conclusion was first made that the signal, although a correct telemetry output, was the result of a faulty switch and that the normal sequence of events should be followed. Further discussion, however, indicated that the safest approach would be to allow the retropackage to remain attached. The retropackage straps would then hold the heat shield in place until sufficient dynamic force was exerted to maintain its position throughout reentry heating. The opinion was that the heat effects of the retropackage on the capsule heat shield and afterbody would not be damaging. Therefore, the pilot was directed during the retrofire maneuver over CAL to keep the retrojettison switch in the disarm position. The remainder of the flight was normal, and no other major system malfunctions occurred. It must be strongly emphasized that with a pilot in the spacecraft to make decisions and take corrective action, the malfunctions which occurred would have made an unmanned flight extremely difficult, and these quite possibly could have resulted in failure to reenter the spacecraft and effect successful recovery.

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Mercury Network Performance

Mercury Network performance was excellent, all systems were fully operational at lift-off, and the few minor malfunctions which occurred did not affect the flight monitoring and control of the mission. Acquisition of data from tracking, telemetry, and air-ground voice systems was satisfactory in both quantity and quality for real-time monitoring and postflight analysis. The relaying of air-ground voice back to the Mercury Control Center (MCC) from all sites with a point-to-point voice capability contributed substantially to the real-time monitoring of the mission.

Tracking.- Radar tracking on this flight was satisfactory and superior to that of MA-4 or MA-5 Missions. All stations provided data for all passes whenever the spacecraft was above their horizon. The quantity and quality of these data were more than adequate. Minor problems existed in S-band phasing and handover, but this caused a negligible loss of data. The communications used for this were satisfactory.

Interference of an unknown source caused some concern on C-band at Cape Canaveral and Bermuda, but this did not cause any extensive loss of data. It is apparent that the extensive maintenance, training, and refinement of tracking procedures for the network has yielded dividends. Satisfactory C-band tracking was accomplished during most of the "blackout" period. Two Cape Canaveral radars had satisfactory S-band tracking for the first two minutes of blackout, and they were then turned off because the end of their range interval had been reached.

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S- and C-band Radar-tracking coverage is shown in figures 50 and 51 respectively. The performance of acquisition-aid was satisfactory, and, in all cases acquisition was accomplished without difficulty.

Data transmission.- The transmission of both high-speed and low-speed data was satisfactory throughout the mission.

Trajectory Computation.- At lift-off, the selected source for display at the MCC was the output of the IP 7090. FPS-16 tracking at Cape Canaveral was utilized until approximately 00:00:50, at which time the IP 7090 switched to AZUSA tracking was displayed for approximately the next 20 seconds, at which time General Electric-Burroughs data through Goddard Space Flight Center was selected and was displayed throughout powered flight. The General Electric radar acquired both rate and track at 00:01:08 and never lost lock throughout the remainder of the boost phase. The quality of the General Electric data was excellent up to SECO and during the GO-NO-GO computation.

The programed phase of the flight showed minor deviations of $+0.75^{\circ}$ in flight-path angle and $+1.0$ n.m. in altitude at BECO. After launch vehicle staging guidance corrected these deviations. A maximum deviation of $+2.8$ n.m. in crossrange and a residual of $50+$ fps in yaw velocity existed at cutoff. The yaw velocity looked very good up to approximately 35 seconds before cutoff, but it then appeared to lack response to steering with the final results as stated above. There appears to be conflicting evidence on this particular point, since the calculated impact point at the Canary Islands Station was right on the expected ground track, which

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is difficult to resolve with a residual velocity of 50 fps in yaw. It was later disclosed, however, that an error in the scale of the plotboard at the MCC existed, which accounts for this misrepresentation in your velocity. The cutoff conditions displayed in MCC are listed in table XVIII.

Low-speed tracking data from the remote sites were excellent, that the orbit was well-defined by the end of the first orbital pass. Subsequent tracking during the second and third passes showed negligible improvement in the orbit parameters. The number of radar observations received from each site is shown in table XIX.

The "A" computer was lost during the second pass between Hawaii and California. A restart was made in less than 5 minutes using the HAM vector, thus, the computer was ready to accept the White Sands data. A malfunction of the "B" computer caused the Texas and Eglin data for the second pass Eglin data on reentry to be ignored.

During the reentry, tracking data appeared to pinpoint the landing location with a high degree of confidence, and the final values from the Goddard computers indicated only 2 n.m. difference between the landing location as obtained from the California Station data and the Cape Canaveral FPS-16 data (see table XX). However, the landing point as reported by the recovery ship, as well as that computed by the Cape IP 7090 computer using Cape Canaveral and San Salvador FPS-16 data, does not agree with the Goddard computations.

The actual landing point was 39 n.m. short of the planned location. The weight loss of RCS fuel, attributable to the requirement for manual

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control during two orbital periods, was much greater than anticipated. This weight difference contributed the major error of 31 n.mi. from that predicted, since the lower weight for a given quantity of retrograde impulse will result in a higher negative velocity increment at retrofire. A variation in spacecraft attitude during retrofire resulted in an additional error of 4 n.mi., and a slightly greater impulse than the normal value provided another 2 n.mi. deviation. These factors account for 37 n.mi. of the actual landing point discrepancy.

The low-frequency cyclic noise pattern was apparent in both General Electric-Burroughs and AZUSA data, but this was slightly lower in amplitude than that for the MA-5 Mission and much lower than MA-4. At insertion, General Electric gave an inertial velocity of 25,727.6 feet/second and an inertial flight-path angle of -0.0674 degrees, while AZUSA figures were 25,733.3 and -0.0907 , respectively.

Telemetry.- The data provided by the telemetry system was adequate and of good quality. Coverage was satisfactory, with data acquisition at all stations throughout each pass whenever the spacecraft was above the radio horizon. Coverage is shown graphically in figure 52 (a, b, and c) and in tabular form with decommutator figures, range and elevation in table XII. Signal strengths were satisfactory, ranging up to 400 microvolts. Several sites reported low signal levels when compared with previous missions.

Ionization blackout of telemetry began at approximately 04:42:52, as seen at Canaveral, and ended at approximately 04:47:14, as seen at

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Grand Turk. Thus, the blackout period lasted 4 minutes and 22 seconds. Data flow charts were drawn up based on the telemetry summary messages from the sites. The majority of the data points fall within ± 3 percent of a faired curve. A few exceptions were evident, however, in that figures from several sites were consistently off the faired curves of fuel quantity by as much as 10 percent as shown in figure 53.

Air-ground voice.— The performance of the primary air-ground voice system (UHF) was good throughout the mission. Signal strengths were adequate enough to provide excellent signal-to-noise ratios whenever the spacecraft was above the local visual horizon. In most instances, RF refraction increased the coverage over visual line-of-sight by one to two minutes of arc. UHF in-range times averaged almost seven minutes per orbital pass.

The HF voice system provided some additional coverage, but, as expected; it was not as satisfactory as the UHF was of particular value during the first and third passes where the Canary, California, Guaymas, Zanzibar, Indian Ocean Ship, Muchea, and Canton Stations were able to converse with the astronaut beyond the capability of the UHF system. It is interesting to note that in some instances where the HF was being used as the spacecraft approached the station, the quality of communications improved considerably as the elevation angle became positive, particularly as the switch was made to UHF.

Figure 54 shows approximate coverage compared with times above the visual horizon. Through the air-ground voice system, MCC was able to

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to follow the recovery procedure and monitor all conversations until after the spacecraft was aboard the recovery ship.

Command System.- The command system for MA-6 operated in a satisfactory manner during the mission. The few airborne-system anomalies are discussed below. The 600-watt stations appeared to have had coverage beginning at a slant range of 400-450 N.M., and the 10 KW stations had coverage beginning at a slant range of 650-700 N.M. A summary of the command handover exercises is shown in Table XXII and a summary of the command transmissions is shown in Table XXIII.

Ground System: There were several problems involving the command equipment and the coder relay panels during the month prior to launch, however, no delays in the launch countdown resulted. A total of eleven (11) functions were successfully transmitted from the sites: Auxiliary Sustainer Cutoff (ASCO) was transmitted from San Salvador, three sets each of R and Z calibrations were transmitted from Mucnea, and two sets each of R and Z calibrations were transmitted from Cape Canaveral. Command coverage from all sites was satisfactory with the exception of Mucnea on the third pass. A combination of slant ranges in excess of 450 nautical miles, airborne antenna patterns, and 600 watts of RF power resulted in only one minute and 30 seconds of coverage above receiver threshold.

Airborne System: Command Receiver "A", operating from the 18-volt isolated bus, appeared to be much more sensitive to signal strengths above 30 microvolts than Receiver "B", which operates from the 18-volt

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standby bus. Below 30 microvolts both receivers' operation coincided. The onboard recorded signal strengths although acceptable, were about 6 db, or less, below those of the MA-4 and MA-5 missions. The reason for the difference in recorded signal strengths is not known at this time, however, this magnitude of decrease is of no great concern. The airborne antenna pattern problem, which was experienced on MA-4 and MA-5, was again evident from the MA-6 onboard records. Spacecraft attitude changes are definitely reflected on the signal strengths records. Ionization blackout occurred on the Command frequency between 04:43:03:5 GET and 04:47:12 GET.

Triggering of the "All-Function Events Channel" occurred five times during ionization blackout. The tone channels triggered are unknown, but are coincident with a burst of signal into the receivers. It is known that the tones keyed were not clock changes, R and Z calibrations, nor Mayday. Later tests of the communication revealed that interference between the telemetry and UHF voice transmitters produced a signal with a frequency on the edge of the command receiver bandwidth. An increase of 0.5 MC in the low TM frequency has apparently corrected this. The characteristics of the inputs to the command receivers are shown as oscillograph record reproductions in figure 55.

What is assumed to be random noise with a signal strength from one to 4 microvolts was recorded between 01:14:00 GET to 01:15:07 GET.

Command carrier was not present during this period.

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Ground communications.- All the ground communications networks provided good support for the mission. Except for a few short prelaunch outages, all the voice, teletype, and datalines were available at all times, and the quality of transmission was satisfactory. Single-sideband voice communication with the two ships was very satisfactory, as provided by AMR. Part of the link from the Indian Ocean Ship had to be relayed through Ascension Island.

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NASA - Manned Spacecraft Center
Langley Air Force Base, Va.
December 12, 1961

MEMORANDUM for Flight Director Attn: Mr. C. C. Kraft

Subject: Report on Test 5460 (MA-6)

Location: Mercury Control Center

Position: Procedures

Date: February 20, 1962

A. Permission activities

1. Simulation. - A total of four separate abort drills were performed on 1/13/62, and again on 1/16/62 with the GSC, BDA and MCC sites. These drills primarily exercised the MCC-BDA decision capability in reference to the Mission Rules. Five additional drills were performed again on 2/9/62. These were performed after the reschedule of Test 5460 to 2/14/62. A total of seven network drills were performed in preparation for this test. The network reached a peak in performance as indicated from the results and evaluation of the data and time required for data transmissions during the F-2 day operation on 1/25/62, Test 5460B-2. All subsequent net drills indicated a lesser performance on the part of the Net Flight Controllers. Possibly the network had reached a peak in 5460B-2, and later simulations lacked some motivation.

The simulations during the entire pretest period were very realistic, skillfully executed, and provided excellent training for the Flight Control Teams. The simulation personnel should be proud of their contribution to the success of the over-all mission.

2. Scheduling. - A brief resumé of the network activities schedule is presented in appendix A.2. There were no major scheduling problems as a result of the several delays in launch. The only major discrepancy that was noted was the lack of Flight Controller support at three sites on F-1 day. This support is mandatory in order to clear all message traffic, and avoid unnecessary query traffic on F-0 day.

3. Documentation. -

(a) Data Acquisition Plan - This document was excellent for this test. Changes to the D.A.P. constituted less than 10 percent of the total ISI traffic.

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(b) Countdown - All countdowns became stable very early during the pretest activity. One revision was made to the original MCC countdown document. This revision rearranged status checks to match spacecraft countdown.

(c) Mission Rules - Revisions E, F and G were written to the Mission Rules after Flight Controller deployment to the sites. Basic changes made in these rules were:

(1) Addition of thruster temperatures (Revision E)

(2) Rewrite of rulings relative to oxygen quantities and simplification of control mode requirements (Revision F)

(3) Further simplification of control mode requirements, and changes to prelaunch requirements in the ECS and aeromed Area (Rev. G)

All rule changes were transmitted to Mercury Network by ISI.

(d) Flight Plan - The Flight Plan for this test required extensive revisions by ISI. For the next test the Flight Plan must be coordinated through all agencies prior to Flight Control deployment.

(e) ISI's - A total of 59 ISI's were written for this test. The majority of this data was new information not available prior to deployment. The information contained in the ISI's can be broken down in the following 7 general areas:

(1) 3 ISI's to notify network of mission status

(2) 19 ISI's concerning instructions for range instrumentation

(3) 8 ISI's concerning telemetry calibration instructions for meter scales and event level settings

(4) 4 ISI's concerning mission rule revisions

(5) 6 ISI's concerning Flight Plan revisions

(6) 13 ISI's concerning documentation revisions

(7) 6 ISI's concerning corrections to previously transmitted ISI's.

(f) Queries - A total of 108 queries were received from the sites. All queries were answered prior to lift-off.

B. Countdown. - Basically the countdown went very smoothly. All Flight Control Teams were on site at T-3 hours for Test 5460.

1. Voice checks. - A total of nine voice checks were conducted during the minus time count. The results of these checks indicated that all voice lines were satisfactory. The voice check conducted at T-90 was performed with the sites A/G voice loop patched into the Goddard conference voice loop. The proper level settings were obtained and the results of Test 5460 indicated that the A/G reception on the Goddard conference loop at MCC was of exceptionally good quality throughout the mission. During the T-35 voice check, a severe echo was noted on the GYM voice loop. The Communication Director at Goddard reported the cause of this echo was due to a speaker termination at Tucson. This problem was soon rectified. All confidence summaries were transmitted at the proper time with the exception of the MUC summary, which was late and was further delayed due to a data flow test which was conducted at T-145. The results of the confidence summary evaluation indicated that all values transmitted, with the exception of CYI were within 2 to 3 percent of the expected value. CYI was notified of the 7 to 12 pps error in their values by the voice loop. The error, which was found to be in transcription and meter reading, was immediately corrected.

The GSFC voice check at T-55 interfered with HF Subnet No. 4 checks which were conducted at the same time. This voice check will be moved to T-60 in future net counts. No other discrepancies were noted. Over-all support of the net count was excellent.

2. Flight Control Reporting. -

(a) Telemetry - The Remote Sites monitored telemetry almost continuously from lift-off through the WOM Site. There were several breaks in T/M coverage of 5 to 10 minutes duration during the first and second orbits. The longest gap in coverage occurred between WOM and HAW on the third orbit and was approximately 15 minutes duration. The Remote Sites transmitted 165 TTY messages during real time. The over-all message flow was very smooth, and no major traffic delays occurred.

The summary messages comprised the major portion of the raw data used in the test. There were no major discrepancies in summary data, and all parameters were within 3 percent deviation from the established trends when plotted. The majority of data presented smooth trends; however the plots of both a-c voltages, 24-volt d-c main, and some read-outs

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of fuel quantities were erratic. The over-all average summary transmittal time was 6.5 minutes, which approached the times obtained during the simulations.

(b) A/G and Goddard Conference Loop - The A/G loop was patched into the Goddard Conference Loop. This method of passing the astro voice to the network sites was most satisfactory in producing useful real-time data. Virtually all transmissions to and from the spacecraft while over voice sites were read by all other voice sites in the network in real time. This eliminated the necessity for a considerable amount of site briefing by MCC and queries to MCC from the Remote Flight Controllers.

The voice loop characteristics were excellent, and contributed greatly to the total information flow for this test. There were no dropouts in the conference loop during plus time. Loop voice checks were performed in plus time using FP-4 voice loop.

Single side band voice capability to the ATS and IOS was provided through the AMR range facilities. This voice contact provided useful data to the MCC, and direct contact was obtained to the ATS. The ATS voice loop quality was comparable to the full period loops, and systems reports from this site were excellent. Direct voice to the IOS was obtained; however, relay was required through Antigua and Ascension of voice from the IOS.

C. Recommendations

1. Mercury Control Center.-

(a) Raw data inputs to the Operations Room be reduced as much as possible to enable Ops Room Flight Controllers to evaluate data, rather than reduce data. This can be accomplished to a degree by the following methods:

(1) Greater use of personnel in Data Room by implementation of closed circuit TV to present trends, and plot data

(2) Use of 12-inch opaque projector to present summary tabulations. This can be accomplished by converting LH Control Room Trend Plots into a screen, and using the opaque projector.

(b) A Coordination Loop should be established between the following stations: FCD, CEM, CSM, NSM, NST and Data Reduction. In addition, talk capability on both FP-2 and FP-4 should be provided from the Data Room.

(c) SSB Voice should become a firm requirement on the AMR, and should be planned for the F-2 day simulation. In addition, a talk key should be provided on the Flight Director's console.

(d) PAO should be relocated in the Control Room so that his press briefings do not interfere with Intercommunications in MCC.

(e) The Procedures Area should be divided into two responsibilities:

(1) Data Control

(2) Flight Control Coordination

2. Network.-

(a) Data Transmissions should be further reduced. This can be accomplished by implementation of negative reporting for the next test. A sample summary format is in work at the present time.

(b) Flight Plan should be published earlier to allow adequate and comprehensive revision prior to deployment of Flight Control Teams.

(c) The Two-CapCom arrangement worked well, allowing good information flow on both A/G and Goddard Loops and should be retained for future tests.

(d) Two-way A/G communications over the Goddard Loop should be attempted from MCC. This would be an initial step toward enabling a central communicator to maintain worldwide communications with the spacecraft.

(e) All Flight Control Teams should be given a specific work assignment which would be accomplished in the event of a schedule change. This could include detailed study of site systems, revisions to established documentation, etc. This would give the Flight Controllers more continuity between their work assignments while at MSC, and also while on site.

SUMMARY

In summary, the remote site operation was satisfactory. Flight Control Teams were able to acquire, evaluate, and transmit real-time

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data. The data flow has improved considerably from the previous test. The teletype and voice communications network provided for rapid and efficient transmittal of data to MCC with little or no message loss or garbling in transmissions. The A/G loop when patched into the conference loop provided the most useful real-time data.

Eugene F. Kranz
AST, Flight and Range Coordinator

EFK:cmw

Enc:

1. Schedule of MCC activities
2. Procedures Log
3. Composite message summary

+ SCHEDULE OF MCC ACTIVITIES

Doc 1

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1/7	1/8	1/9	1/10	1/11	1/12 MCC FC DEPLOYED	1/13 TEST 5460 J-1,2,3,4 ISI 1,2,3
1/14	1/15 MCC-BDA-GSFC ABORT DRILLS 5460 H-1,2,3,4	1/16 ISI 4,5	1/17 TEST 5460-F ISI 6,7	1/18 ISI 8	1/19 TEST 5460-E ISI 9,10,11,12	1/20 ISI 13,14,15,16, 17,18
1/21	1/22 TEST 5460-B ISI 19,20,21	1/23 ISI 22,23,24	1/24 TEST 5460 SCHEDULED SLIPPED TO 1/27 ISI 25,26	1/25 TEST 5460 BB ISI 27,28,29,30, 31,32,33	1/26 ISI 34,35,36, 37,38	1/27 TEST 5460 SCHEDULED SLIPPED TO 2/13
1/28	1/29	1/30 TEST 5460 BBB ISI 39	1/31 MCC F.C. LEFT FOR MSC ISI 40	2/1	2/2	2/3
2/4	2/5	2/6	2/7	2/8 MCC F.C. LEFT FOR CAPE ISI 41,42,43	2/9 TEST 5460-H2 A,B,C,D,E ISI 44	2/10 ISI 45,46,47
2/11	2/12 TEST 5460 B-4 ISI 48,49,50,51, 52	2/13 TEST 5460 SCHEDULED SLIPPED TO 2/14 ISI 53,54,55	2/14 TEST 5460 SCHEDULED SCRUBBED (WEATHER) ISI 56	2/15 TEST 5460 SCHEDULED SCRUBBED (WEATHER)	2/16 TEST 5460 SCHEDULED SCRUBBED (WEATHER)	2/17
2/18 TEST 5460 B-5	2/19 TEST 5460 P-1 PRECOUNT ISI 57	2/20 TEST 5460 LIFTOFF 14:47:39Z ISI 58,59	2/21 POST LAUNCH REPORT	2/22 POST LAUNCH REPORT	2/23 PRESIDENT KENNEDY AND GLENN VISIT MCC	2/24 MCC F.C. LEFT FOR MSC
2/25	2/26	2/27	2/28	3/1	3/2	3/3

PROCEDURES LOG

T TIME	GMT	OCCURRENCE
	084000	UP AND AT IT.
-196 (N.C.)	084400	SSB CHECK - RESULTS VERY POOR DUE TO SUDDEN IONOSPHERIC DISTURBANCES. EXPECT BETTER COMMUNICATIONS AT 1130Z.
	085000	BOOSTER TLM TO INTERNAL.
	085300	MCC INTERCOMM VOICE CHECK - OK.
-180	090200	FLIGHT CONTROL VOICE COMMUNICATIONS CHECK ON GODDARD LOOP. (REFER TO VOICE LOG FOR RESULTS).
	090500	GMT SYNC ON GODDARD LOOP. BDA GIVEN PERMISSION TO CONDUCT CMD CHECKS BETWEEN 0900Z - 1000Z. MCC CMD CHECKS.
	090900	REPORT THAT BLOCKHOUSE LOST DECOMMUTATOR CAPABILITY. MCC WILL PROVIDE READOUTS.
	091100	TIME SYNC.
	091400	MCC F.C. COMMAND CHECKS COMPLETE.
	091800	MCC ENVIRONMENT REPORT - R CAL ON OXYGEN PARTIAL PRESSURE IS INVALID ON LO LINK.
	092000	TROUBLE WITH MCC ENVIRONMENT SANBORN RECORDER, OK.
-156	092400	FD WEATHER BRIEFING TO BDA. MCC TELEMETRY CONFIDENCE SUMMARY RUN.
	092700	NETWORK STATUS MONITORS REPORT TO FD.
	093000	FIDO REPORT TO FD. RETRO REPORT TO FD.
	093400	MESP CHECK STARTED. T-175 CONF (TRAJ) RUN OK.
	093600	BDA COMMAND CHECKS COMPLETED AT 0929Z.
	093700	MCC TELEMETRY CONFIDENCE SUMMARY COMPLETE.
	093800	VALID CAPSULE TELEMETRY.
	094900	ASTRONAUT EXPECTED TO LEAVE HANGAR 20 MINUTES LATE.

T TDC	GMT	OCCURRENCE
	095500	TELETYPE RESTRICTED DUE TO CADFISS. MUC CONFIDENCE TELEMETRY SUMMARY WILL NOT BE TRANSMITTED. EXPECT ONE-HALF HOUR DELAY DUE TO TELETYPE RESTRICTION. MESP CHECK COMPLETED. OK. ASTRONAUT COMPLETED HANGAR CHECK, GOING TO TRANSFER VAN.
-120	095900	FLIGHT CONTROL COMMUNICATIONS CHECK ON GODDARD CONFERENCE LOOP. (REFER TO VOICE LOG FOR RESULTS).
	100100	ASTRONAUT IN TRANSFER VAN.
	100200	MCC FD - MISSION RULE REVIEW ON GODDARD CONFERENCE LOOP. CYI RECEPTION POOR, TRANSMISSION TO US GOOD.
	100300	TRANSFER VAN LEAVES HANGAR.
	100500	GYM TIME STANDARD GREEN.
	101300	PAO ARRIVES.
	101400	DURING PROCEDURES VOICE COMMUNICATIONS CHECK, ECHO PRESENT ON FP-2. DISAPPEARED SOON.
	101700	FURTHER DELAY IN MUC CONFIDENCE SUMMARY TRANSMISSION, DUE TO DATA FLOW TEST. TRANSFER VAN IN PAD AREA.
	101800	TELETYPE RESTRICTION LIFTED.
	102000	ALL CONFIDENCE SUMMARIES ARE IN. READY FOR ASTRO INSERTION.
	102200	TRANSFER VAN HAVING TROUBLE WITH MOPIS CIRCUIT. CONFLICTING REPORTS, NO - YES? BLOCKHOUSE STATUS REPORT GO.
	102500	CAPSULE/BOOSTER STILL HOLDING. EXTEND HOLD AN EXTRA 30 MINUTES TO REPLACE G.E. RATE BEACON IN LAUNCH VEHICLE.
-120	103000	HOLD CONFIRMED - G.E. RATE BEACON.
	103400	WEATHER REPORT TAKEN AT 1030Z. MCC CAPCOM REPORT TO BDA CAPCOM

(Continued)

T TIME	GMT	OCCURRENCE	Area C	E	F	G	H
103400	(Cont'd)	Wave Height	6	3	3	2	2
		Wind Velocity	25	12	8	6	14
		Wind Direction	160	047	097	160	115
		Cloud Base	1600	2000	2000	2000	3000
		Visibility	10	Unlim	8	10	10
103800		WHERE DID RETRO CMD COME FROM - OK. TWO ISI's TRANSMITTED DURING COUNT.					
104700		ATS TRANSMITTED THIRD CONF SUMMARY. FIRST AND SECOND WERE NOT CLEAR DUE TO COMMUNICATIONS DIFFICULTIES, THIRD ONE OK.					
105000		FC VOICE COMMUNICATIONS CHECKS ON GODDARD CONF LOOP. (REFER TO VOICE LOG FOR RESULTS). MCC INSERTION STATUS CHECK GO. WILL INSERT ASTRO 15 MINUTES BEFORE RESUMING COUNT.					
105400		EXPECT 15 MINUTE HOLD FROM 1100Z.					
105500		BH TELEMETRY DECOMMITATOR PROBLEM CLEARED.					
105700		SECOND CYI CONFIDENCE SUMMARY TRANSMITTED TO MCC.					
105800		START ASTRO INSERTION (LEAVING VAN).					
110300		ASTRO FIRST FOOT IN CAPSULE. SYSTEMS REPORT TO FD, 59 LBS. OF FUEL ONBOARD, MORE THAN NORMAL. WILL FOLLOW-UP WITH MSG TO NOTIFY NETWORK.					
110600		ASTRO BACK TO PORTABLE VENTILATOR TO ADJUST RESP SENSOR.					
110700		EXTEND HOLD DUE TO ASTRO BROKEN MICROPHONE LEAD. WILL REPAIR WITH BACKUP HELMET IN TRANSFER VAN. ESTIMATE 10 MINUTE HOLD.					
110900		DIFFICULTY WITH RESP RATE EQUIPMENT. 40% HIGH ON BASE LINE. PROBABLY 10% HIGHER WHEN VISOR CLOSED. THIS SHOULD RESULT IN WIDER SWEEP OF WAVE INDICATION IN GROUND EQUIPMENT DURING FLIGHT. OD WANTS INTEGRITY OF SUIT - LEAVE AS IS.					
111000		BLEW FUSE ON PHOTO LIGHT IN CAPSULE - OK.					

T TIME	GMT	OCCURRENCE
	111600	SINGLE SIDE BAND CHECK. VOICE COMMUNICATIONS STILL POOR.
	112000	FC VOICE COMMUNICATIONS CHECK ON GODDARD CONF LOOP. (REFER TO VOICE LOG FOR RESULTS). EXPECT TO RESUME COUNT IN 5 MINUTES. ASTRO MICROPHONE REPAIRED
	112300	BLOOD PRESSURE CHECK, EXG ARE ALL GO. SUIT PURGE STARTED.
-120	112500	PICK UP COUNT. ALL COUNTS ARE IN SYNC.
	112600	PERISCOPE RETRACT CHECK OK. MED BRIEFING TRANSMITTED TO NETWORK.
	112800	FIDO REPORT TO FD. SECOND TEST FROM G.E. SATISFACTORY. SUIT PRESSURE CHECK STARTED.
	113400	NSM REPORT TO FD AT 1132Z. CMD AIRPLANE IS AIRBORNE (BETWEEN MCC AND BDA).
	114400	SSB CHECKS. NO CONTACT WITH VICTOR. OTHER COMMUNICATIONS VERY POOR.
	114700	LIFT-OFF CHECK OK.
	114800	RESULT OF GAS ANALYSIS - GO.
	114900	CAPSULE ECS FUNCTIONS COMPLETED. ECS IS GO. COUNT IS GOING ON SCHEDULE.
	115000	FD STATUS REPORT - MCC IS GO.
	115100	FC COMMUNICATIONS CHECK ON GODDARD CONF LOOP. (REFER TO VOICE LOG FOR RESULTS). VOICE CHECK WAS WITH A/G LOOP PATCHED TO GODDARD VOICE LINE.
	115800	HATCH CLOSURE STARTED.
	120100	WEATHER IS FAVORABLE. STARTED TO WRAP UP WHITE ROOM. HATCH PINS INSTALLED. CABIN PURGE STARTED.

T TIME	GMT	OCCURRENCE
	120400	RESULTS OF SUB-NET NO. 1 HF CHECK. ALL STATIONS ARE READING LOUD AND CLEAR.
	120500	Z AND R CAL CHECK. 0 ₂ PARTIAL PRESSURE R CAL ON LO LINK IS OK.
	120600	AMR CHECK - CMD CARRIER ON.
	120700	SSB CHECK. GOOD CONTACT WITH THINKER 12, NO OTHER CONTACT. THINKER 12 READING VICTOR AND QUEBEC OK.
-75	121000	T-75 TRAJECTORY RUN STARTED. 90% OF HATCH BOLTS INSTALLED. BROKEN BOLT, MAY HAVE TO REMOVE HATCH. WOULD TAKE APPROX. 9 MINUTES TO REMOVE STUD, IF DOME NUT REMOVED WOULD TAKE 30 MIN. DECISION BY CD TO REMOVE HATCH AND REPAIR. ESTIMATE 30 MIN. HOLD AT T-60.
	121600	REMOVING HATCH TO REPAIR.
-60	122500	HOLDING FOR APPROX. 30 to 60 MIN. BEST TIME EXPECTED FOR WEATHER 1430Z.
	123700	PROCEEDING WITH HATCH INSTALLATION.
	124100	FIDO REPORT TO FD - GO. RETRO REPORT TO FD - GO.
	124200	60% OF BOLTS INSTALLED. ASTRO VIEW OUT OF SCOPE - "LOOKS LIKE WEATHER IS BREAKING UP."
	124700	SSB CHECK. DIRECT CONTACT WITH VICTOR LOUD AND CLEAR.
	125000	START CABIN PURGE. HATCH INSTALLATION COMPLETE, SHINGLES GOING ON. EXPECT TO PICK UP COUNT AT 1300Z.
	125600	CABIN PURGE COMPLETED.
	125800	HOLD EXTENDED TO ADDITIONAL 5 MIN., CLEAR UPPER DECKS AND CLEAN UP OPEN ITEMS. ESTIMATED CABIN LEAK RATE 500 CC/MIN.
-60	130500	T-60 AND COUNTING. WILL COUNT TO T-45 AND HOLD FOR ADDITIONAL FUEL. TELETYPE RESTRICTED, DATA FLOW TEST.

T TIME	GMT	OCCURRENCE
	131000	FC COMMUNICATIONS CHECK ON GODDARD CONF LOOP. (REFER TO VOICE LOG FOR RESULTS). CHECK INTERRUPTED BECAUSE OF HE CHECKS BEING CONDUCTED BY REMOTE SITES.
	131200	CLEARING ALL DECKS ON GANTRY.
	131800	GANTRY REMOVAL AND LOX STATUS CHECK WILL BE DELAYED UNTIL T-45 (EXPECTED TIME OF HOLD).
	131900	ASTRO CHECKLIST STARTED.
-45	132500	HOLDING. GANTRY REMOVAL AND LOX STATUS CHECK.
	132800	COMPLETION OF CAPSULE SWITCH POSITION TEST - GO.
	132900	MCC FC ARE GO.
	133000	SSB CHECK - DIRECT CONTACT WITH VICTOR, RELAYING VIA THINKER 12 TO QUEBEC. ARM ABORT SYSTEM.
	133200	MCC HAS CAPSULE RF, LO LINK PRIMARY. ON EXTERNAL POWER.
	133300	GYROS TO LAUNCH ANGLES. PROCEED WITH LOX.
-45	133500	PICK UP COUNT.
	134100	BDA AND ATS TTY RED. WILL NOT DELAY COUNT. BOTH CAPSULE FUEL READOUTS EXPECTED TO BE 5 TO 10% LOWER THAN GROUND READOUTS.
	134600	GSFC NET COMMUNICATIONS ARE GREEN AND GO.
	134800	SSB CHECK. CONTACT WITH VICTOR AND QUEBEC VIA THINKER 12.
	135000	BH STATUS CHECK GO. CAMERA COVERAGE EXPECTED TO BE 100% AT ALL ALTITUDES. BDA REPORTS CONSIDERABLE INTERFERENCE ON CHANNELS 30 and 31 OF TTY - OK - CAUSED BY CHANGING OF PATCH.
	135500	FD STATUS REPORT TO CTC - GO. AZUSA ON EXTERNAL POWER.
-22	135800	HOLDING. LOX VALVE STUCK (GSE). ESTIMATE 15 MIN. FOR THIS HOLD.
	140100	SYSTEMS REPORT TO FD. INDICATIONS OF 150 VA INV COLD PLATES NOT OPERATING PROPERLY. PRESENT READING 160°F. EXPECTED RISE OF 7° per/hr. EXPECTED TO STABILIZE AT TEMP OF 190 to 200°F.

T TIME	GMT	OCCURRENCE
	140100 (Cont'd)	LOOKS LIKE COLD PLATES HAVE FROZEN UP.
	141100	ADDITIONAL 10 MIN. HOLD TO TOP OFF LOX. CABIN PRESSURE HOLDING AT 15.2 PSI.
	141800	FC VOICE COMMUNICATIONS CHECK ON GODDARD CONF LOOP. (REFER TO VOICE LOG FOR RESULTS). ECHO ON LINE BELIEVED TO BE CAUSED BY SPEAKER AT TUSCON.
	142200	SSB CHECKS. MOC T/R TO VICTOR LOUD AND CLEAR. NOT ABLE TO READ QUEBEC, QUEBEC READING US VERY WEAK. THINKER 12 (RELAY) LOUD AND CLEAR.
-22	142300	WE ARE COUNTING.
	142500	CMD CHECKS. RETRO TO NETWORK VIA VOICE.
	142800	BOOSTER CMD CHECKS COMPLETED - GO.
	142900	CMD VOICE CHECKS GOOD.
	143000	C.O. BE ADVISED, "SMOKING LAMP IS OUT". COMPUTERS RECYCLING, DATA GOOD.
	143200	150 VA INVERTER TEMP HOLDING AT 168°F.
	143300	BDA COMPUTER LOST POWER. ESTIMATE 5 MIN. TO REPAIR. WILL KEEP COUNTING.
	143400	CAPSULE TO INTERNAL POWER. 2 AND R CAL.
	143700	FC VOICE COMMUNICATIONS CHECK ON GODDARD CONF LOOP. (REFER TO VOICE LOG FOR RESULTS).
-6:31	143800	HOLDING FOR BDA COMPUTER. ESTIMATE 5 MIN. HOLD.
-6:31	144100	WE ARE COUNTING.
-18 sec.		FIRING SIGNAL.

T TIME	GMT	OCCURRENCE
	144739	LIFT-OFF ----- 144739 GMT BECO ----- 214 GET TOWER SEP ----- 233 GET SECO ----- 504 GET CAP SEP ----- 504 GET
	145149	GOOD RECEPTION FROM FRIENDSHIP 7.
	145240	"WE ARE THROUGH THE GATES".
	145300	FIDO REPORT TO FD - 7 ORBIT CAPABILITY, APOGEE 138 N.M.,
	145524	CAPE LOS.
	145534	BDA REPORT CONTROL SYSTEMS CHECK STARTED, CAPSULE AND ASTRO ARE GO.
	145824	BDA TELEMETRY AND TRACKING LOS. ASTRO WILL CONTINUE SYSTEMS CHECKS OVER CYI. CAPE RECEIVING HF COMMUNICATIONS FROM FRIENDSHIP 7 - READABLE.
	150000	FRIENDSHIP 7 REPORT TO CYI - CONTROL SYSTEMS CHECKS PERFECT.
	150200	EXCELLENT A/G VOICE FROM ASTRO ON GODDARD CONF FROM CYI. REPORT: 150 VA INV TEMP - 175°, CABIN TEMP - 95°, SUIT TEMP - 70°. ASTRO REPORT: AUTO FUEL - 90%, MAN FUEL - 98%. "HORIZON BRILLIANT BLUE".
	150600	"PICKED UP CYI VIA SCOPE AND AFRICAN COAST THRU THE WINDOW, WINDOW VIEW IS MUCH BETTER." MEDICAL STATUS IS GREEN. CYI CAPCOM REPORT TO FRIENDSHIP 7 - "MAN FUEL LINE TEMPS 100°, AUTO FUEL LINE TEMPS 70°."
	150800	ASTRO IS SLIGHTLY BEHIND ON CHECKLISTS. ASTRO IS STILL ON ASCS.
	150900	MONITORED KNO CAPCOM CALLING FRIENDSHIP 7 - GOOD , MCC NG
+37		SSB REPORT FROM ATS - MONITORED YAW MANEUVER OVER KNO - GOOD.
	151200	ASTRO TOOK XYLOSE.

T TIME	GMT	OCCURRENCE
	152300	KNO REPORT: CAP UHF HI/LO CHECKS OK.
	153500	NSM REPORT TO FD. FOREIGN C-BAND RADAR IDENTIFIED DURING POWERED FLIGHT. UNABLE TO DETERMINE EXACT SOURCE.
	153700	CAPSULE OVER MUC. CAP AND ASTRO ARE GO. A/G ON GSFC IS LOUD AND CLEAR. R AND Z CAL COMMANDED BY MUC CAPCOM. ASTRO REPORTS VERY BRIGHT LIGHTS OBSERVED OVER AUSTRALIA.....
	154300	CAPSULE OVER WOM. A/G ON GSFC IS LOUD AND CLEAR. SSB REPORT FROM IOS - ASTRO AND CAP WERE GO OVER THEIR STATION. COULD NOT SEE WOM AIRPORT LIGHTS DUE TO CLOUD COVERAGE. NO "G" EFFECTS. ELAPSED CAP TIME SYNC WITH GET. 150 VA INV TEMP - 195°. 250 VA INV TEMP - 172°. CABIN TEMP - 100°. CABIN PRESSURE - 5.5 PSI. BLOOD PRESSURE CHECK - 125 OVER 90. ASTRO ON HF COMMUNICATIONS - ALL SYSTEMS ARE GO. WOM CONFIRMS. POST RECEIVED FROM IOS - IOS FLARED IGNITION 153211Z. NO ASTRO SIGHTING DUE TO 9/10 CLOUD COVERAGE.
	160900	GYM CMD CARRIER ON. A/G HF PUT ON GSFC AT GYM. MCC RECEIVING LOUD AND CLEAR. CABIN TEMP - 100°, ASTRO REPORTS THAT LITERALLY THOUSANDS OF SMALL PARTICLES APPROX. 16TH OF AN INCH IN DIAMETER FLOATING PASS THE WINDOW, AND TRAVELING AT ABOUT THE SAME SPEED AS CAPSULE. THIS OCCURRENCE WAS FIRST REPORTED ON CTN'S POST. GYM REPORTS GROUND INDICATION OF SCOPE RETRACT, ASTRO REPORTS SCOPE IS OUT.
013100		ASTRO REPORT: YAW DRIFTED OFF 20° TO RIGHT, CONTROL BACK TO 0° MANUALLY, BACK ON ASCS. GYM CAPCOM REPORTS ASCS IS STILL DRIFTING IN YAW.

T TIME	GNT	OCCURRENCE
	162100	ASTRO REPORT TO MCC CAPCOM - ASCS TROUBLE STARTED AT GYM, DRIFTING AT APPROX. ONE DEGREE PER SECOND. I AM NOW ON FEW AND CONTROLLING MANUALLY. NO 1 LB. THRUSTER YAW RIGHT. MCC CAPCOM RECOMMENDS ASTRO REMAIN ON FEW.
014400	162700	MCC GROUND READOUTS INDICATE IMPACT BAG DEPLOY. OVER BDA ASTRO REPORTS NO ADVERSE AFFECTS FROM OCCULOGYRIC TEST.
014900		ASTRO REPORTS TO CYI ALL SYSTEMS ARE GO EXCEPT ASCS TROUBLE IN YAW. COULD NOT CORRELATE SMALL PARTICLES PASSING WINDOW WITH ACTION OF JETS. SYSTEMS MONITOR AT CYI OBSERVES ROLL IGNORE.

T TIME	GMT	OCCURRENCE												
01:53:00		SSB REPORT FROM ATS: ATS HAS UHF CONTACT. ATS REPORTS A CHANGE IN ASCS YAW PROBLEM, IT IS NOW IN THE RIGHT YAW THRUSTER, ASTRO REPORTED LEFT YAW THRUSTER OVER MCC. ASTRO CONDUCTED HIS 180° YAW MANEUVER WITH VERY GOOD RESULTS, ATTITUDES HELD GOOD. REPORT FROM _____ THAT A BOLT WAS FLOATING IN THE CABIN.												
02:01:00		MCC REQUEST STATIONS TO MONITOR SEGMENT 51. (LANDING BAG DEPLOY). INSURE THAT ASTRO HAS LANDING BAG SWITCH IN THE OFF POSITION. NO SSB CONTACT WITH IOS.												
02:28:00		MUC REPORT: SEGMENT 51 IS ZERO PFS. CAPE ADVISES ASTRO TO CONDUCT HORIZON CHECK, ALSO CHECK GYROS BEFORE CAL.												
0235		ASTRO REPORT TO WOM - EXCESS CABIN WATER AND FUEL LIGHTS ARE ON IN CABIN.												
02:50:00		A/G PATCHED TO GSFC AT HAW. ASTRO CAGED AND UNCAGED GYROS ON DARK SIDE, IS RECHECKING AGAIN. ROLL ATTITUDE APPEARS TO BE 20° OFF WHEN ALIGNED WITH GROUND. DRIFT RATE VERY DIFFICULT TO DETERMINE. ASTRO AND CAPSULE STATUS GOOD. ASTRO CONSIDERS "GO" FOR THE NEXT ORBIT. REPORT OF ATTITUDES AT HAW: <table border="1"> <thead> <tr> <th></th> <th>ASTRO</th> <th>GROUND</th> </tr> </thead> <tbody> <tr> <td>ROLL</td> <td>+19°</td> <td>+10</td> </tr> <tr> <td>YAW</td> <td>+2°</td> <td>0</td> </tr> <tr> <td>PITCH</td> <td>-422°</td> <td>-+20°</td> </tr> </tbody> </table> ROLL HORIZON SCANNER MAY NOT BE WORKING ON THE DARK SIDE OF EARTH. ASTRO REPORT THAT IT IS HARD TO GET VISUAL REFERENCE IN (ROLL OR YAW?)		ASTRO	GROUND	ROLL	+19°	+10	YAW	+2°	0	PITCH	-422°	-+20°
	ASTRO	GROUND												
ROLL	+19°	+10												
YAW	+2°	0												
PITCH	-422°	-+20°												
03:05:00		TEX REPORT: ASTRO IS PITCHED DOWN IN ORDER TO MAKE OBSERVATIONS												
03:06:00		CHD CARRIER ON (MCC)												
03:08:00		MCC RECOMMENDS THAT ASTRO ALLOW CAPSULE TO DRIFT IN ORDER TO CONSERVE FUEL.												
03:37:00		SSB ATS: GYROS SEEM TO BE IN ERROR. ASTRO CAGED GYROS AND PLACED BACK TO NORMAL, HAD A DISSAGREEMENT BETWEEN WINDOW AND ATTITUDES: <table border="1"> <tbody> <tr> <td></td> <td>+20° ROLL ERROR</td> </tr> <tr> <td></td> <td>+20° PITCH ERROR</td> </tr> <tr> <td>TLM READINGS:</td> <td>PITCH -34°, -32 HS</td> </tr> <tr> <td></td> <td>PITCH OUTPUT, ROLL -0°,</td> </tr> <tr> <td></td> <td>-10° HS ROLL OUTPUT.</td> </tr> <tr> <td></td> <td>NO IGNORES.</td> </tr> </tbody> </table>		+20° ROLL ERROR		+20° PITCH ERROR	TLM READINGS:	PITCH -34°, -32 HS		PITCH OUTPUT, ROLL -0°,		-10° HS ROLL OUTPUT.		NO IGNORES.
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	-10° HS ROLL OUTPUT.													
	NO IGNORES.													

T TIME	GMT	OCCURRENCE		
03:58:00		MUC: A/G REPORT, NO LOW (ROLL YAW) RIGHT THRUSTER IN FEW..... SUIT PRESSURE 5.8, ASTRO WILL CONDUCT REENTRY ON ASCS AND BACKUP ON THE MANUAL SYSTEM.		
04:11:00		FD INSTRUCTIONS TO HAW CAPOOM: CHECK IMPACT BAG DEPLOY LIGHT. PUT IN AUTO POSITION, IF HE GETS LIGHT, MAY REENTER WITH RETRO PACKAGE ON; IF NO LIGHT, RETURN SWITCH TO OFF POSITION AND WILL REENTER WITHXRETEX IN NORMAL SEQUENCE. MCC CAPSULE SYSTEM RECOMMENDS GET RID OF PACKAGE IN NORMAL MANNER. DATA REDUCTION RECOMMENDS KEEP PACKAGE ON DURING REENTRY.		
04:24:00		SSB REPORT: ASTRO ON FEW NOT ASCS. CAPSULE OVER HAW . ASTRO ON ASCS BUT ATTITUDES ARE NOT HOLDING, ATTITUDES ARE IN AND OUT.		
04:32:00		CAL CAPOOM RECOMMENDS TO ASTRO TO KEEP RETRO PACKAGE ON UNTIL OVER TEX.		
04:32:38		REPORT ON GSFC LOOP: RETROSEQUENCE 04:32:38 RETRO ROCKET FIRED 04:33:09, RETRO ROCKET FIRED 04:33:20 (EVENT LIGHT), ATXMXRETEX RETRO ROCKET FIRED 04:33:25 (EVENT LIGHT), ATTITUDES HELD RIGHT ON DURING RETROFIRE.		
04:36:40		ASTRO OVER COAST. FD INSTRUCTION TO TEXAS CAPOOM, LEAVE RETRO PACKAGE ON FOR REENTRY THEREFORE MUST MANUALLY RETRACT SCOPE AND MANUALLY OVERRIDE .05G AT APPROXIMATELY 044359. TEX REPORTS: SCOPE RETRACT LIGHT GREEN, ASTRO MANUALLY RETRACTED SCOPE. USED FEW AND BACKED UP WITH MANUAL DURING REENTRY.		
IP DISPLAY INFORMATION (PROCEDURES CONSOLE)				
TIME		LAT.	LONG.	REMARKS
HR	MIN			
19	36	2108	6801	BASED ON RETROFIRE
19	36	2132	6855	
19	36	2129	6848	WHITE SANDS CORRECTION
		2129	6848	WITH TEX DATA - NO CHANGE
19	36	2131	6853	BASED ON 2nd CORRECTION ON CNV DATA.
ASTRO TO JETTISON RETRO PACKAGE AT 1.5G COMMUNICATIONS WITH ASTRO AFTER IGNITION BLACKOUT. ASTRO IS OK DROGUE OUT SNORKEL OPEN MAIN CHUTE ON GREEN, A BEAUTIFUL VIEW. DESTROYER HAS CHUTE IN SITE AND HAS COMMUNICATIONS WITH ASTRO.				
04:52:00		ESTIMATE CAPSULE PICKUP IN 20 MINUTES. LANDING BAG IS ON GREEN. APPROX.		
0453		SHIP REPORTED TO BE WITHIN/6 MILES OF PREDICTED IP.		
04:55:30		IMPACT. DESTROYER TALKING WITH ASTRO. MCC PC IS READING ASTRO TRANS- MISSION LOUD AND CLEAR. CAPSULE IS RIDING GOOD IN WATER.		

T TIME	GMT	OCCURRENCE
0458		ASTRO REPORTS CONDITION IS EXCELLENT.
0516		CAPSULE AND ASTRO ON DECK. ASTRO COMING OUT THROUGH THE TOP. HAD SOME DIFFICULTY, WILL BLOW HATCH OFF AND EGRESS THROUGH HATCH.
0533		HATCH BLOWN AND IS CLEAR
0534		ASTRO ON DECK.

Test 5460
Composite Message Summary

TIME	ORIG	TO	TYPE	TEXT
1448	MCC	ALL	GETS	144739Z
1452	MCC	ALL	SPE	Capsule successfully inserted, 7 orbit capability. Capsule and astro GO. Nominal cutoff.
1452	MCC	ALL	PAD	Use V/VR equal 1.0 for setting radar plotboard altitude scale.
1455	MCC	LOS		
1455	MCC	ALL	PAD	GMT LO 144739, ECTRS 043228, Area 1 Bravo GMTTC 150529, ECTRC 001750, ICTRC -04:-15:+22
1457	MCC	ALL	SUM	
1458	BDA	LOS		
1500	BDA	ALL	SUM	
1500	EGL	MCC	GEN	EGL tracking at liftoff: TM contact: 144911Z ACQ aid 144912Z - 145300Z full auto MPQ-31 145045Z - 145202Z passive auto FPS-16 144915Z - 145145Z IRAQ All bcons good. C-band 25; \$;3. S-band 28 DB above.; 5.# -, \$ 5.) 795# 899\$ -528 DB above TIM &10, TIM E -44. LOS at 083 deg AZ.
1501	CYT	MCC	CON	150003Z HF
1503	MCC	ALL	GEN	Glenn
1504	MCC	ALL	BRF	Astro status - excellent thru launch. Clear voice transmissions. Highest pulse rate 120 was 96 at LOS. EKG normal. Very fine GO. All systems GO. 12% fuel used on turnaround on auto system. ECS - all GO.
1505	BDA	ALL	SPE	Correction to SUM Primary O2 pressure 76 vice 75
1507	IOS	GSC,MCC	GEN	The 20K wind too much for balloon release will sue parachute flares.
1507	MCC	ALL	PAD	GMT LO 144739, ECTRS 043228, Area 1 Charlie GMTTC 151951, ECTRC 003212, ICTRC -04:+00:-16. End of orbit Foxtrot GMTTC 161627, ECTRC 012848, end of mission Hotel GMTTC 192017, ECTRC 043238
1510	CYT	LOS		

TIME	ORIG	TO	TYPE	TEXT
1510	KNO	MCC	CON	150852Z TM III LO
1514	CYT	ALL	SUM	
1514	ZZB	GSC,MCC	STAT	All green except RF interference 20/1450 NOID T/M LO /// /// Noise 13DB AZ 312 EL 0
1515	WOM	GSC,MCC	STAT	A/G red magnecorder inoperative ETO 1530Z
1516	KNO	LOS		
1516	MCC	ALL	PAD	GMT LO 144739, ECTRS 043228, Area 1 Delta GMTTC 153803, ECTRC 005024, ICTRC -04:+18:-04, Area 1 Echo GMTTC 160321, ECTRC 011542, ECTRC -03:-17:+14. End of orbit Foxtrot GMTTC 161629, ECTRC 012850, end of mission Hotel GMTTC 192021, ECTRC 043242
1517	ZZB	MCC	CON	151728
1517	MCC	ALL	PAD	Retroseq times for land landing at 98.5 deg. W. long. at end of orbit one GMTTC 160723 ECTRC 011944
1518	MCC	ALL	PAD	GMT LO 144739 ECTRS 043228 Area 1 Delta GMTTC 153758 ECTRC 005019 ICTRC -04:+18:-09
1519	CYT	MCC	POST	Part one. 1. Flight plan. Astro made observations of Canary Islands and African coast. Stated that the window gave better view than periscope. Part of Canary Islands were covered with clouds. Noticed a dust storm over Africa. Stated the horizon was brilliant blue.
1520	KNO	ALL	SUM	
1521	KNO	MCC	POST	Part one Completely normal pass Auto fuel 90, Man fuel 98, Main 02 98, sec 02 100

TIME	ORIG	TO	TYPE	TEXT
1522	KNO	MCC	POST	Part 2 Astro status GO. Sounds excellent on voice. Took XYLOSE at 15:11:56. EKG excellent with negligible sinus arrhythmia.
1522	CYT	MCC	POST	Part two Astro status excellent. EKG normal with rate at 105 falling to 90 and lowest level at 95. Complexes normal. QRS 0.08 PR 0.16. Resp TIM steady between 12 to 15 but not particularly deep as anticipated. Only one BP performed over station with clear readout 120/80. Psychiatric status superb. Clear, calm and confident reporting of data. Exhaust duct temp IPTD 60 deg. Astro stated that he was slightly behind in Flight Plan but was trying to catch up. Rel. Hum RPTD 3.0. No stick movements observed by TIM confirming ASCS.
1522	WHS	GSC,MCC	STAT	All green except RF interference 20/1445Z NOID TM HI 8640 KC /// 18 to 22 microvolts 110 AZ modulated
1523	KNO	MCC	POST	Part 3 Exhaust temp 59 deg. UHF hi and lo check OK. Yaw maneuver performed in FBW mode. FBW performance excellent in all axes
1525	CYT	MCC	POST	Part 3 All systems normal. Attitudes held in orbit mode. 150VA temperature held at approx. 178 degrees. TIM was solid throughout pass.
1526	ZZB	LOS		
1528	IOS	MCC	CON	152800Z
1528	WHS	GSC,MCC	STAT	All subsystems green RF interference resolved
1531	ZZB	ALL	SUM	

TIME	ORIG	TO	TYPE	TEXT
1532	CYI	MCC	POST	POST PAST Part 1 2) astro stated cabin temp 90 but was comfortable and would not adjust coolant flow 3) astro readouts TIM readouts Cabin pressure 5.7 5.9 Cabin temp 90 100 Suit temp 65 70 AC volts ASCS 112 118 Fans 112 118
1534	ZZB	MCC	POST	B) aeromed Status throughout pass AOK. Blood press 136/80 before exercise - 136/76 after. Visual Acuity including astigmatic test nominal. No impediments head movement or reach accuracy. Suit exhaust temp 61. EKG without apparent abnormalities - a follow-up on this will be sent.
1534	WOM	GSC,MCC	STAT	A/G green
<u>1535</u>	<u>IOS</u>	<u>LOS</u>		
1535	ZZB	MCC	POST	A) Mission Flight Plan followed and indicates capsule and astro still GO. Attitudes agree with periscope. Astro readouts agreed with TM.
1539	IOS	ALL	SUM	
1539	ZZB	MCC	POST	Capsule systems All capsule systems green. Inverter temperature steady over station.
<u>1541</u>	<u>MUC</u>	<u>LOS</u>		
1541	MCC	ALL	GEN	PAO network acquisition statement PIO No. 2 cleared (1) Bermuda (2) 15:31 (3) 9:51 (4) good (5) John Glenn (6) He could see back to the cape (7) (8) good (9) (10) 140 (11) 17,500 (12) 15:31 (13) 10:31 (14) 19:47 (15) 2:47 est.
1542	MUC	MCC	SPE	R cal suit inlet +10 pfs 150 VA temp plus 5 pfs 250 VA temp +6 pfs Z cal AOK
1544	MUC	ALL	SUM	

TIME	ORIG	TO	TYPE	TEXT
1545	IOS	MCC	POST	A. Mission status. Flight Plan is on schedule. Astro observed sunset. Described as beautiful. Sky above black, thin band of blue along horizon. Partly cloudy below, some stars visible but no constellations identifiable. Mortar flare from ship not visible. B. Astro status excellent. No complaints, no effects from weightlessness. C. Capsule systems. All TIM readouts appear normal. Astro increased setting of suit comfort control to 1.7 LB per hours. Astro voice loud and clear on UHF. Astro readings: auto fuel 90, man fuel 98, main O₂ 75, sec O₂ 100, DC amps 21, suit press 5.5.
1547	MCC	ALL	BRF	Astro status continues excellent thru one half first orbit. Pulse rates 76-90-B.P. Reported 120 to 130 over 80 to 90. Confident - clear. No EKG variations reported. All Flight Plan experiments on visual acuity, head movement, and moving lights are nominal.
1550	WOM	LOS		
1552	WOM	ALL	SUM	
1552	MCC	MCC	GEN	Correction to SUM GMT LOS 154506
1553	HAW	MCC	GEN	Have intermit H.F. interference FMR A/C is checking. Inter. is broadband noise.
1555	ZZB	MCC	POST	B) Aero-med Follow-up confirms no arrhythmia except normal sine v variation of minimal degree. No suggestion of abnormal vagal effects during approximately 8 min of record P-R equals 0.17, QRS equals 0.09, Q-T equals 0.40 at heart rate of 88 at acquisition. Blood pressure before exercise 13/84 with heart rate jump peak heart rate 140 returning within one minute at AI blood pressure of 136/8('75 -1534 3/34:83. No significant interval variations noted although difficult to read during exercise. Respiration record hard to interpret.
1557	CTW	MCC	CON	155713Z
1558	WOM	MCC	GEN	CCC SUM 2241 201552Z 150VA inv temp to read 195 vice 19.5

TIME	ORIG	TO	TYPE	TEXT
1558	MUC	MCC	POST	NR. 1. All systems satisfactory to continue mission. Z and R CAL accomplished. Star, weather, and landmark reports were accomplished. Lites of Perth and nearby other cities were observed very clearly. Astro reported sighting the plades just west of here. Reported high thin band of haze approximately 8 degrees above horizon. Cloud cover over Africa cleared gradually and weather was clear over west coast of Australia. Nr. 2. Astro status excellent. Blood pressure checked here prior to LOS. Respiration readout difficult to interpret probably due to verbal reporting by astronaut during the pass. Nr. 3. All systems satisfactory.
1559	WOM	MCC	POST	1. Astro completed 30 min report 2. Excellent. Results of physiologic tests were good. 3. All systems good. All TIM data excellent UHF good.
1601	MCC	ALL	PAD	GMT LO 144739, ECTRS 043228, Area 2 Alpha GMTRC 162417, ECTRC 013638, ICTRC -03:+04:+10. Area 2 Bravo GMTRC 163739, ECTRC 015000, ICTRC -03:+18:-28. End of orbit Foxtrot GMTRC 161629 ECTRC 012850; End of mission Hotel GMTRC 192020, ECTRC 043241
1604	CTN	LOS		
1604	MCC	ALL	PAD	GMT LO 144739, ECTRS 043228, Area 2 Delta GMTRC 172610, ECTRC 023831, ICTRC -02:+06:+03 Area 2 Echo GMTRC 173638, ECTRC 024859, ICTRC -02:+17:-29
1605	MCC	ALL	PAD	GMT LO 144739, ECTRS 043228, Area 2 Charlie GMTRC 165338, ECTRC 020559, ICTRC -02:-26:-29. End of orbit Golf GMTRC 174820, ECTRC 030041
1606	CTN	ALL	SUM	
1610	CAL	GSC,MCC	GEN	Correction to SUM Heart rate 80
1610	CTN	MCC	POST	1. Mission status - astro following flight plan. Reported no difficulty eating. Reported very small particles near capsule moving at approx capsule speed. Brilliantly lit up by sunrise.
1612	CTN	MCC	POST	2. Astro status - 3. Capsule status - RR temp 78° - All systems good

TIME	ORIG	TO	TYPE	TEXT
<u>1621</u>	<u>CAL LOS</u>			
<u>1621</u>	<u>GYM LOS</u>			
1622	CAL	ALL	SUM	
1622	WHS	MCC	POST	Had TM hi interference prior to first pass. Problem resolved. Good C-band beacon - 1st valid track data is on rabbit. 161850 valid track data actually valid.
1623	GYM	MCC	POST	Aeromed Astro status excellent. EKG 1 and 2 of good quality. Pulse rate 80 at acq 100 midpass and 80 at LOS. Respirations 12 throughout pass. Blood pressure 136/76 one reading only. Nothing abnormal reported by astro.
<u>1624</u>	<u>TEX LOS</u>			
1625	CAL	MCC	POST	Mission: Good FFS-16 auto track. Good UHF reception. Astro: status one. ECG 1 and 2 of good quality with no abnormalities. BP 130/76. Respiratory trace unreadable. Capsule: No scope retract sig present. Retro temp 78. Yaw was drifting to 220 at LOS. 150 VA inverter 200 deg.
1626	GYM	ALL	SUM	
1628	ZZB	GSC,MCC	STAT	All green except RF interference 20/1525Z Appears to be thunderstorm activity T/M lo T/M hi /// Noise 15-20 DB AZ 260 EL 0
1629	GYM	MCC	POST	Mission: GO. at about 013200 astro report right yaw drift. He went to man. to correct it. Back on ASCS, it drifted. It appears that there is no left yaw lo thrust. Astro observed small particles floating along with him.
1629	TEX	ALL	SUM	
<u>1629</u>	<u>MCC LOS</u>			

TIME	ORIG	TO	TYPE	TEXT
1629	GYM	MCC	POST	Systems: Scope retract Seg 62 showing 30 percent level from capsule T/M, confirmed by visicorder read-out. Scope extended at all times during pass. Capsule instrumentation signal level shift suspected.
1630	TEX	MCC	POST	Part 3: Capsule system A. SCS drifting in yaw while in ASCS. Went on FBW to correct which appears to overcome trouble. C. A/G voice handover of A/G voice was direct to Cape from GYM.
1630	CAL	ALL	SUM	Correction Heart rate -1 BP 130/76
1632	BDA	LOS		
1632	MCC	ALL	SUM	
1634	BDA	ALL	SUM	
1636	CAL	ALL	GEN	Correction to SUM: Heart rate 80
1636	CYT	MCC	CON	163602Z
1637	EGL	MCC	POST	Part 1: Good track all systems. C-band max range in to max range out. C-band beacon 25 dB above at 700K, 42 db above at CPA (245K), 10 percent countdown. S-band beacon 27 db above at 310K with 10 percent countdown. Good sharing TML 44 db at CPA. Good Cband plot. Good HF and UHF recordings.
1638	MCC	ALL	PAD	GMI LO 144739, ECTRS 043228. End of orbit Golf GMTRC 174818, ECTRC 030039. End of mission Hotel GMTRC 192018, ECTRC 043239.
1640	ATS	MCC	CON	163938Z TM
1641	CYT	ALL	SPE	Intermittent roll ignore over CYT
1641	MCC	ALL	BRF	Astro status at completion of orbit 1 is excellent. Pulse rates varied from 84 to 102. Highest pulse associated with reporting. Steady at 84 at LOS. Resp. wave poor quality difficult to read with talking. EKG 1 and 2 were excellent quality and normal complexes. P-R interval is 0.20. Q.R.S. is 0.09. Oculogyric tests at BDA pass 2 were nominal. Operating on FBW, No. 1 thruster apparently

TIME	ORIG	TO	TYPE	TEXT
con't - 1641	MCC	ALL	BRF	not working in left yaw, orientation mode in ASCS OKay inverter temperature tending to stabilize. H ₂ O ₂ line temperatures less than 100 percent and holding.
1642	CYI LOS			
1643	KNO	MCC	CON	164226 TM HI LO
1646	ATS LOS			
1649	KNO LOS			
1649	CYI	ALL	SUM ME	
1649	ATS	MCC	CON	164110Z
1650	IOS	GSC, MCC	GEN	High winds make balloon release impossible. Cloud coverage is 7/10. Will use parachute flares but observation changes very slim.
1652?	ATS	ALL	SUM	
1652	KNO	ALL	SUM	
1652	ZZB	MCC	CON	165152Z
1653	CYI	MCC	POST	Part 2 Astro status excellent. Psychological status remains superb and astro seems unhurried and calm. ENG remains normal with no arrhythmias with rate from 75 to 90 and 90 LOS. QRS 0.08 PR 0.16 resp sensor giving poor readout. Astro asked to breathe deeply and good TIM readout then received average rate about 12. No BP test performed. Stick movement TIM readout did not appear to correlate exactly with flight plan sequence but astro stated he had perfect control. Astro stated he felt quite a bit of heat thru window but was no uncomfortable.
1654	KNO	MCC	POST	Part 1 Auto fuel 76, man fuel 100, main O ₂ 68, sec O ₂ 100 amps 25
1654	MCC	ALL	PAD	Retrosq times for land landing at 103 deg. W. long. at end of orbit two GMTRC 173958, ECTRC 025219
1655	KNO	MCC	POST	Part 2 Second pass completely normal status remains excellent

TIME	ORIG	TO	TYPE	TEXT
1655	ATS	MCC	REPOST	Aero-med - ECG trace is normal astro voice sounds confident. Flight plan - 180 deg yaw maneuver done, Astro was returning to 0 deg yaw at LOS. He liked the view at 180 degs. Systems - all systems OK reported bolt floating in cabin.
1656	KNO	MCC	POST	Part 3 Intermittent pitch and roll ignore. Astro reports no low thrust right control. Has low thrust control to left. Astro departing from flight plan to check out yaw control of ASCS. TIM indicated correct orbit attitude when in ASCS but astro doubtful about yaw attitude.
1656	KNO	MCC	GEN	Correction to SUM Sec 02 press should read 100
1658	ZZB	IOS, MCC MUC	SPE	Trouble in ASCS has reversed. ASCS not holding all times. Manual handle pulled.
1658	MCC	CAL, CTN, HAW MUC, WOM	SPE	Request you read out segment 51, landing bag deploy. Advise astro to keep landing bag in off position. If bag is down astro should hear banging against capsule for high rate inputs.
1658	CYI	MCC	POST	Part one: 1. Astro performed day horizon check. Astro stated he had no problem controlling capsule attitude using the horizon as a control reference. 2. Astro could not correlate particals with thruster action. 3. Astro observed cape verde Islands.
1659	ZZB	LOS		
1659	ZZB	IOS, MCC, MUC	SPE	Intermittent pitch ignore 150V temp 205 250V 192

TIME	ORIG	TO	TYPE	TEXT
1700	MCC	CAL, CTN, HAW, MUC WOM	SVC	RE YY94 Send ACK
1701	IOS	MCC	CON	170108Z/170108Z
1703	WOM	MCC	ACK	ACK YY94 20/1658Z
1704	MUC	MCC	ACK	ACK YY94 20/1658Z
1704	HAW	MCC	ACK	ACK YY94 20/1658Z
1704	ZZB	ALL	SUM	
1704	IOS	MCC, MUC, WOM	SPE	Capsule dropped into orientation mode on ASCS now on manual. Auto fuel 62 with warning light on.
1705	CTN	MCC	ACK	ACK 94 20/1658Z
1705	CAL	MCC	ACK	ACK YY94 20/1658Z
1705	ZZB	MCC	POST	A) Mission Flight Plan partially followed. 30 min report not given fully due to problems occurring in ASCS. Landing bag switch off.
1708	ZZB	MCC	POST	Aero Med: All Aeromed data normal including reach accuracy, head motion, visual acuity, EKG. No astigmatism. Respiratory trace shows no shift when not talking. Insufficient time for blood pressure and exercise. Suit exhaust temperature 47. P-R interval equals 0.17, QR equals 0.08 QT equals 0.37 all with heart rate 86.
1708	CYT	MCC	GEN	Segment 51 landing bag deploy deflect ED 85 percent both high and low T/M
1710	IOS	LOS		
1714	MUC	ALL	SPE	Seg 51 zero PSF TML
1715	ZZB	MCC	POST	Capsule Systems 150V inverter temperature began to rise again this station following fluctuating trend previously established. ASCS not holding at all times. The trouble in yaw has reversed. Low right yaw thruster not operating over this station. Astro had manual handle pulled to use as backup. Observed intermittent pitch ignore. All other systems green.

TIME	ORIG	TO	TYPE	TEXT
1715	IOS	ALL	SUM	
1715	MCC	ALL	GEN	PAO supplemental PIO statement. Cleared. Astronaut John Glenn has completed one half of his planned 3 orbit mission. The astronaut and all systems in the spacecraft and world-wide tracking network were performing satisfactorily as of 12:15 EST (17:15 ZULU). Voice contact with the astronaut continues good.
1718	MUC	MCC	SPE	Z cal all OK. R cal suit inlet temp plus 10 PFS. 150 VA plus 4 PFS. 250 VA plus 8 PFS.
1719	MUC	LOS		
1720	IOS	ALL	GEN	Correction to SUM HS roll out should read &3 to &18.
1721	MUC	ALL	SUM	
1721	GYM	MCC	GEN	Short transmission heard on HF from Hickham Field, Hawaii.
1723	WOM	LOS		
1723	IOS	MCC	POST	A. Mission status. Astro now seeing stars, however problems with ASCS not permitting Astro to pitch capsule into good observation attitude. Astro did not see flare due to complete cloud cover horizon check AOK. B. Astro AOK - no problems. C. Capsule systems GO except for ASCS. Capsule dropped into orientation mode over station, astro switched to full manual control. Auto fuel warning light on in capsule. Astro headings: Auto fuel 62, man fuel 90, main 02 68, sec 02 100, amps 20.
1724	MCC	ALL	PAD	GMT LO 144739/144739 ECTRS 043228/043228 Area 3 Alpha GMTRC 175906/175906 ECTRC 031127/031127 ICTRC Minus 01 Hrs minus 21 min minus 01 sec Area 3 Bravo GMTRC 181015/181015 ECTRC 032236/032236 ICTRC minus 01 hrs minus 10 min plus 08 sec.
1727	WOM	ALL	SUM	
1728	MUC	MCC	POST	NR. 1. All systems appear satisfactory for continuing mission. Z and R calcs sent. Astro reported seeing Orion clearly. Astro confirmed landing

TIME	ORIG	TO	TYPE	TEXT
Continued 1715	ZZB	MCC	POST	bay switch off and does not hear banging noise at higher rates. Astro completely satisfied with FBW and manual proportional control systems. NR. 2. Astro status excellent. Astro reports no effects from weightlessness. NR. 3. FBW LO right yaw thruster inop. Both FBW HI thrusters OK. Astro reports fuel 60 85, oxygen 65 100, amps 22, exhaust temp. 50. oxygen consumption from primary system the same as nominal over this site.
1731	CTN	MCC	CON	BQUEPTWZ/173052Z
1731	MCC	ALL	PAD	GMT LO 144739/144739 ECTRS 043228/043228 Area 3 Charlie GMTRC 182757/182757 ECTRC 034018/034018 ICTRC /minus 01 hrs; plus/ 08 min; /minus 10 sec Area 3 Delta GMTRC 190012/ 190012 ECTRC 041233/041233 ICTRC plus/ 00 hrs; /minus 20 min; plus/ 05 sec
1733	KNO	MCC	GEN	REUR 20/1658Z Checked seg 51 on visicorder and at LOS 83 PCT signal was indicated.
1733	MCC	ALL	BRF	Astro status thru one and one half orbits remains excellent. Pulse rate 80 - 100 BP at MJC 126/80. Observed 5 degree rise in suit temp during second orbit. Body temp 98.8 to 99.0 Flight Plan interrupted due to attitude control problems.
1737	CTN	LOS		
1737	MCC	ALL	PAD	CET is slow by one sec compared to GET. This should be subtracted from all retros EQ. Times previously given.
1738	WOM	MCC	POST	1. 30 min check partially completed. Exercise not conducted. 2. Good blood pressure 125/80. 3. Control system man - OK in all axes. FBW-inoperative in low right yaw. ASCS - Orbit mode in yaw inoperative orientation mode was operative in yaw but orientation mode effected all three axes attitudes.
1739	CTN	ALL	SUM	
1744	HAW	LOS		

TIME	ORIG	TO	TYPE	TEXT
1744	CTN	MCC	POST	1. Mission status - astro following Flight Plan. Reports sighting thousands of particles extending to limit of vision. These were visible at sunrise.
1745	CTN	MCC	POST	2. Astro status - 1 3. Capsule status seg 51-0 PFS All yaw HI thrusters OK. Inverter temps high but stabilized.
1748	HAW	ALL	SUM	
1749	MCC	ALL	BRF	Control system as of 17:47Z manual control system OKAY fuel usage not excessive auto system all high thrusters OKAY in either FBW or ASCS
1751	MCC	ALL	GEN	All sites disregard reporting on seg 51.
1752	WHS	MCC	POST	TM-HI best signal - good C band beacon - 88 and 40 DB above noise.
1752	HAW	MCC	POST PASS	Aero Med EKG intervals: PR-0.30; QRS 0.08; QT - 0.40 at rate of 88; classically normal complex configuration.
1753	CAL	LOS		
1754	GYM	LOS		
1755	IOS	MCC	GEN	High winds and 9/10 overcast makes balloon release impossible and parachute flares impractical for third pass.
1755	MCC	ALL	GEN	Supplemental PIO statement. Cleared. Astronaut John Glenn is going into the third orbit. Astronaut, spacecraft and ground tracking systems continue to perform satisfactorily.
1756	GYM	MCC	POST	Medical. Astrostatus excellent. EKG 1 and 2 of good quality with normal complexes. Pulse rate steady at 82 to 88 throughout pass. Respiration shows poor trace but readable at times at 12 per minute.
1757	TEX	LOS		
1757	CAL	ALL	SUM	
1757	GYM	MCC	POST	Mission: Astro report excess cabin H2O indic. flow almost complete off.

TIME	ORIG	TO	TYPE	TEXT
1758	CAL	MCC	POST	Mission: Good UHF. GO for orbit 3. Astro: Status one. EKG 1 and 2 of good quality with no abnormalities. Astro reports feeling well with negative symptoms. Respiratory trace unreliable. Capsule: Capsule-ground gyro readouts have satisfactory correlation. 150 VA inverter temp rise 215-220 during pass.
1758	HAW	MCC	POST	Correction - EKG intervals: PR-0.20 vice PR-0.30.
1759	GYM	ALL	SUM	
1800	MCC	LOS		
1801	GYM	MCC	POST PASS	Systems: Observed pitch down to -60 with roll between limits of -14 and 25, yaw between limits of -5 and 15.
1802	TEX	ALL	SUM	
1805	BDA	LOS		
1805	TEX	MCC	POST	Part 3: Capsule system A. SCS TIM confirmed pitch maneuver while capsule was over site. Ignore signal was the result of extreme pitch down attitude. B. Clock confirmed new retro sequence setting.
1805	CAL	BDA	GEN	Thanks for the A/G.
1807	BDA	ALL	SUM	
1807	MCC	ALL	PAD	GMT LO 144739/144739 ECTRS 043228/043228 Area 3 Echo GMTRC 190952/190952 ECTRC 042213/ 042213 ICTRC plus/ 00 hrs; /minus 10 min; /minus 15 sec End of mission Hotel GMTRC 192017/ 192017 ECTRC 043238/043238
1810	CYT	MCC	CON	180815Z/180815Z HF
1811	MCC	ALL	SUM	
1811	EGL	MCC	POST	Part 1: Beautiful track all systems. C-band 1000K incoming to 1000K outgoing. Same for S-band. C-band ben 32 DB above at CPA with 8 percent count-down. S-band ben varied in signal strength. Good TM track with TML 50 DB above at CPA.
1812	MCC	ALL	PAD	Retro seq times for land landing at 102 deg. W. long. at end of orbit three. GMTRC 191318/191318 ECTRC 042539/042539
1812	ATS	MCC	CON	181223Z/181223Z TM

TIME	ORIG	TO	TYPE	TEXT
1813	MCC	ALL	BRF	Astro status at completion of orbit 2 is excellent. Confident and in complete charge of situation. Blood press. 136/66 at MCC. BDA astro reports he feels well. Pulse steady between 84 to 90. Resp wave erratic with discussion but appeared to be approx. 12. Body temp. is steady at 99. Astro reports he is comfortable.
1818	CYI	MCC	POST	Astro status excellent. No TLM rcvd. Psychological status remains normal. Stated he has felt normal throughout flight and has experienced no nausea. Further stated he has seen no more particles. He has seen them each time "mainly at sunrise". Astro on man control. Astro readout: auto fuel 62; man fuel 54; main O2 62; sec O2 94; amps 24; HF was loud and clear. LOS for HF 181230Z.
1821	IOS	LOS		
1821	ATS	LOS		
1825	ATS	ALL	SUM	
1827	ZZB	MCC	CON	182827/182827 with HF only
1830	ZZB	MCC	POST	HF contact established for 1 min astro on auto control in all three axes with man backup.
1831	ATS	ALL	SUM	Correction to sum 043228/043228
1834	IOS	MCC	CON	183441Z/183441Z
1837	ATS	MCC	POST	Aero Med - Astro fine. Flight Plan - 30 min report deleted. Systems - capsule attitude instruments did not agree with window. Astro freed the gyros and went to 0, 0, 0 and then caged the gyros. He then returned the gyros to normal and went on ASCS. Communications deteriorated and we switched to HF. He then reported that his attitudes did not agree between window and instruments. Roll att at LOS was 0 deg. HS roll at LOS was -10. Pitch att at LOS was 34 deg. HS pitch at LOS was 32 deg. Astro was on ASCS at LOS. Temperatures were slightly high but holding.
1840	ATS	ALL	SUM	Correction to SUM Suit inlet temp 72 repeat 72
1849	IOS	ALL	SUM	

TIME	ORIG	TO	TYPE	TEXT
1849	MCC	ALL	SPE	All stations are to reply 2nd and 3 orbit tapes for capsule pass. Monitor seg. 51, note time signal on or off, duration of signal, percent of deflection. Forward ASAP by SPE mag.
1851	MUC	MCC	SPE	Z cal OK. R cal suit temp plus 10. 150 VA plus 4. 250 VA plus 8.
1852	<u>MUC LOS</u>			
1852	MUC	MCC	SPE	Seg. 51 HL 85 PFS full pass.
1854	<u>WOM LOS</u>			
1854	MUC	ALL	SUM	
1856	HAW	MCC	SPE	REUR YY109. For 2nd orbit seg. 51 came on at 173836Z/173836Z. ACQ. was at 173640Z/173640Z. Signal level was 82 percent and remained until LOS.
1900	WOM	ALL	SUM	
1900	IOS	MCC	POST	A. Mission status. Astro observations occasionally interrupted by ASCS problems. No flare launched from IOS. Astro reports complete cloud cover. B. Astro status AOK, excellent condition. D. Capsule systems. All AOK except for ASCS/ Astro reported attempting to use ASCS but drifting in yaw. Astro switched to manual control (FEW) to conserve fuel. 02 sec dropped to 90 PCT but astro has not used any. S drop perhaps due to bottle chilling. HF was used during pass with good results. Astro readings: auto fuel 63, man fuel 45, main 02 60, sec 02 90. Reports no low thrust in right yaw, other thrusters AOK. Capsule systems: auto fuel dropped from 60 to 55 over station. Manual fuel dropped from 49 to 45 over station.
1903	CAL	MCC	SPE	REUR 20/1849Z Seg 51 read 85 percent throughout 2nd pass.
1904	KNO	MCC	SPE	Signal on seg 51 on for entire 2nd pass 83 percent deflection. Did not acquire 3rd pass.
1906	CTN	MCC	CON	190311Z/190311Z HF

TIME	ORIG	TO	TYPE	TEXT
1906	CYT	MCC	GEN	Replay of second orbit tape confirms 85 percent deflection segment 51 from acquisition at 163540Z to LOS at 164138Z and solid on both HI and LO for entire pass. No third orbit data.
1908	CTN	MCC	SPE	Seg 51 was 0 PFS through entire pass no 2.
1908	MJC	MCC	GEN	Pass to commandant USMC, Washington DC. Have 4 hours flight time for this month. Request this be entered in records so that I may receive flying pay. EGND: John H. Glenn, Mercury Astronaut, from Friendship Seven
1909	BDA	MCC	SPE	During second pass segment 51 was at 78 PFS at acquisition, midway through the pass, and during the last two minutes of track. These were the times that the visicorder was turned on. During third pass segment 51 was monitored continuously and showed a 78-80 PFS reading throughout.
1911	CTN	ALL	SUM bx VOICE CON	
1911	CTN	ALL	SUM	No TM contact - HF voice contact. Astro report: auto fuel 45; man fuel 45; pri 02 60; sec 02 90; sxps 23.
1912	MJC	MCC	POST	NR. 1. All systems appear satisfactory to continue the mission. 30 minute report completed with only discrepancy LO right yaw thruster in the FEW mode. Command voice check not accomplished. Astro desires to recheck EENS and determine if it is satisfactory to retrofire by ASCS and back up by manual proportional. Astro will realign capsule in daylight and recheck gyros. NR. 2. Astro condition excellent based upon sudden interest in receipt of flight pay. Continued use from primary and secondary oxygen systems indicates some abnormality. NR. 3. LO right yaw thruster inop on FEW. Attitude instrument readings were still differing from visual alignment. Instrument readings from capsule generally agree with TM readings except cabin air temp which shows to rqpq egrael higher than capsule and suit temp which shows TM 5 degrees higher than capsule.

TIME	ORIG	TO	TYPE	TEXT
1913	CTH	MCC	GEN	CW interference on HF at 190808Z. Weak signal. Call letters NES.
1914	ZZB	MCC	SPE	Seg 51 85 PCT for entire second pass.
1915	ATS	MCC	SPE	REUR 20/1849Z Orbit 2 Orbit 3 1. signal on/off unknown unknown 2. Duration of signal continues continues 3. percent of deflection 84 84
<u>1917 HAW LOS</u>				
1917	TEX	MCC	SPE	Seg 51 readout on TIM playback as follows: 1st pass: came on 162240Z remained on thru LOS. approx 82 percent. 2nd pass: on at Con, remained on throughout pass. approx 82 percent.
1919	HAW	ALL	SUM	
1924	CAL	ALL	RTOF	R1 Fired R2 043320/043320 R3 043325/043325 DC current peg 043309/043309 Delta V 400 Att good, some deviation in yaw
<u>1925 CAL LOS</u>				
1925	CAL	MCC	GEN	Correction to sum: 150 VA inv temp shud read 245 250 VA inv temp shud read 230
1926	HAW	MCC	POST	Astro placed landing bag sv. in auto position - no lights. Pre-retro checklist completed OK. Clock reset by astro to 043237Z/043237Z. All systems appear green for reentry.
1926	MCC	ALL	BRF	Retro sequence by clock at 04:32:38 retrofire at 04:33:08, astro held attitudes well during retrofire. All three retros fired.
<u>1927 GYM LOS</u>				
1929	CAL	ALL	SUM	
<u>1930 TEX LOS</u>				
1930	GYM	ALL	SUM	

TIME	ORIG	TO	TYPE	TEXT
1930	WHS	MCC	POST	TM hi best signal - good C-band beacon No problems
1931	MCC	LOS		
1931	GYM	MCC	POST	Retro cmd, retros 1, 2 and 3 on. 30 percent signal, scope retract - ON.
1931	TEX	ALL	SPE	Entering with retro pack Scope retracted manually
1931	MCC	ALL	GEN	PAO Supplemental PIO statement: cleared Data collected from the GYM, Mexico and point Arguello, California Mercury tracking stations confirmed astro John Glenn's voice communication of successfully firing the retro rockets on the blunt heat shield of his MA-6 spacecraft at 2:20 EST today over the west coast of the United States. The reentry trajectory of the craft should bring it down approximately 800 miles (statute) southeast of cape canaveral. Mercury recovery forces are now being directed to the landing area.
1932	GYM	MCC	POST	Medical: Medical readouts indicate astro to be in good condition. EKG 1 and 2 still of good quality. Pulse rate showed little disturbance. during entry being 88 at acq 85 at midpass and 160 just at LOS. Respiration difficult to read and readouts show rate at about 14 per minute. Voice contact indicates astro to be in good condition.
1933	TEX	ALL	SUM	
1937	MCC	ALL	BRF	Reentry appears good. Astro prt drogue looked good
1939	CAL	MCC	POST	Mission: Retro seq initiated by clock at correct GMTFC. Retrofire appeared good. IC current peg on time. No plotboard display. Delta V 400 fps. Some yaw deviation but well within limits. Astro required man control to hold attitude. Astro: status one. ECG 1 and 2 of good quality. No abnormalities. Pulse 105 at retrofire, 85 at LOS. Priority messages prevented request for BP. Capsule: 150VA temp 240 deg. 250 va temp 230 deg. Both radars tracked after retro. Fuel usage 42 to 30 auto 40 to 25 manual. Fuel line temp. dropped 15 deg. when used Retro temp 85 to HHH.
1939	MCC	ALL	BRF	All reentry seq. good. Astro reports main chute confirmed by MCC T/M.
1940	MCC	ALL	BRF	Destroyer steelhead has capsule in sight. Expect pickup in 20 minutes.

TIME	ORIG	TO	TYPE	TEST
1942	HAW	MCC	POST	PULSE 110 AT AOS. Rapidly subsiding to range 84 to 90. Increase to 100 with exercise and return to 80 within 30 secs. Rate 88 at LOS. Sinus rhythm throughout. Intermittent tachypnea to 30 returning to average range of 20. Increase in both rates correlated with reentry checklist.
1942	MCC	ALL	BRF	Astro report landing bag green. Prepared for landing.
1945	MCC	ALL	BRF	Ship within 1000 ft of capsule looks good.
1946	EGL	MCC	POST	Part 1: Good track all systems. C-band bcn 30 DB above at CPA (271 K) with 15 percent countdown. Blackout experienced at C-Band Acq - Resulted in some loss of track. S-band bcn 37 DB above at CPA with 10 percent countdown. S-band track from 1284 K incoming to 1270 K outgoing. TM track rough with TML 42 DBat CPA. UHF was readable.
1950	GSC 12	ALL	GEN	TERMINATE mission TFC rules. Resume ADM tfc. Release critical coverage your areas. WOM turn down -01 ckt within Australia. WOM/MUC shift to -02 only. -20 and -21 will remain up until just prior release from comm coverage today. CYI voice will be turned down immediately after voice debriefing.
1950	MCC	ALL	GEN	Station PIO statement 4 cleared (1) John Glenn (2) 19:44 (3) (4) USS Destroyer NOA (5) About 800 miles southeast of Bermuda.
1951	MCC	ALL	SUM	
2007	MCC	ALL	BRF	CAPSULE IS ABOARD DESTROYER. Astro was in continuous contact with destroyer and Cape during recovery. Astro reports himself in excellent condition.
2019	MCC	ALL	GEN	CapCom and site personnel. Many thanks for ur excellent support during the past test. Your work made today's mission most successful. I look forward to working with you on the next mission. Test 5460 debriefing is tentatively set for 2 March 1962 at STG. Again many thanks, a well done for all participants. Signed Procedures

TIME	ORIG	TO	TYPE	TEXT
2021	MCC	ALL	GEN	Tracking station statement No. 5 Spacecraft and astronaut recovery Tracking Station -- Mercury astronaut (1) John Glenn and MA-6 spacecraft were lifted out of the water by U.S. Navy recovery forces at (3) 3:01 EST and (4) Local time today. The spacecraft and pilot reached the deck of the (5) USS Destroyer NOA at (6) 3:04 EST, some (7) 5 hours 13 minutes after launch. The nation's first orbiting astronaut is undergoing preliminary medical examination aboard the (8) USS Randolph.
1700	MCC	ATS,BDA,CAL CTN,CYI,EGL, GSC,GYM,HAW, IOS,KNO,LDN, MUC,TEX,WHS, WOM,ZZB	ADM	As I pointed out in the verbal debriefing yesterday, the worth of the Mercury network was already proven in the MA-4 and MA-5 flights. However, the tremendous performance of the network during John Glenn's flight far exceeded every expectation any of us had. Every one of you should feel proud as a re- sult of yesterday's work and as much a part of the Mercury team as any member here at Canaveral. My heartiest congratulations go to all of you. I only wish I could shake each hand around the world that had a part in it and maybe someday not too far off that will be possible. My sincere appreciations for your support. Chris Kraft, Flt Dir.

MESSAGE TOTALS FOR TEST 5460
MCC TRANSMITTED -48
SITES TRANSMITTED-165
TOTAL 213

SPECIAL-22
GENERAL 29, includes 7 PAO
POST 58
BRF 14
PAD 19
SUM 40
CON 17
MISC 14

NOTE: This traffic is representative of the Traffic presented to the Flight Control-
lers in the Mercury Control Center. This is not the total mission traffic,
and does not include SVS, Pointing Data, ACQ, etc. Total traffic from liftoff
through termination was 450 messages incoming, 126 MCC broadcast, 15 to
individual sites. Total 591 messages estimated.

NASA - Manned Spacecraft Center
Langley AFB, Virginia
February 22, 1962

MEMORANDUM for Flight Director

Subject: Summary Report on Test 5460(MA-6)

Location: Mercury Control Center

Position: Flight Surgeon

Date: February 20, 1962

1. Summary of Aeromedical Area

(a) The preparation of the astronaut, the biomedical count-down and transfer to the gantry went along with no major problems. However, there were minor discrepancies in times for each operation such that arrival at the gantry was 20 minutes behind schedule. This time discrepancy although not important for this operation due to other holds, will require further examination and practice before the next operation to better calibrate each operation. The astronaut was held in the transfer van at the gantry for approximately 45 minutes for weather.

(b) The insertion of the astronaut was uneventful except for the shift of the respiration sensor by 40 percent from its nominal baseline from that seen between simulated flight and launch day. T/M has no explanation for this at present. This could have been corrected by breaking the integrity of the suit seals but was considered as not desirable on the gantry. The decision between OD and MCC Surgeon was that we would go with the shift even though it degraded the data. Range Medical Monitors were alerted to this by message and reports indicated that satisfactory read-outs were still possible from most stations except where there was a great amount of discussion by the astronaut. The other discrepancy was the fracture of one of the adjustment posts on the helmet microphone. This break occurred during adjustment of the microphone due to the over vigorous aid of the technicians. The microphone was replaced from the backup helmet.

(c) The Aeromedical countdown was uneventful from this point on with no discrepancy. The Aeromedical Area and astronaut were "Go" from this point on. Astronaut physiological data indicated pulse rates of approximately 60 to 80 with a rise to 110 at lift-off. Respiration rate range of 12 to 20 and blood pressure range of 105-135 over 80-95. These small variations, although all normal, were associated with astronaut activity. During the multiple holds, the astronaut was requested

to exercise to maintain comfort and late in the count to maintain warmth after the freon cart operator left the gantry.

(d) Flight Program

During launch, the astronaut was in a "go" status at all times. The changes in physiological responses were minimal. The maximum pulse shift noted on early data showed increases by approximately 1/3. John Glenn was able to maintain voice reports through the nominal accelerations and through RECO and SECO. Voice reports were clear, precise and confident throughout. Within a few minutes after turn around, the pulse rate increase showed decline and stabilized at 85-95 through most of the flight. Throughout the flight, the astronaut appeared to be in excellent condition both from the summary data, the voice reports and the confidence he exhibited during the flight plan. The astronaut deviated from the planned test program during the last orbit due to the difficulties with the attitude control system. However, the astronaut did not report any upsets similar to those attributed to Cosmonaut Titov. The voice loops through the GSFC Loop and the A/G to the recovery ships were excellent aids in the assessment of the astronaut status during flight.

(e) Range Support

Range support at the MCC and range station was excellent. The communications on the Aeromedical net were the best we have seen to date. The consistency of the data from station to station was excellent. Flight Controller reporting was complete and timely. The medical monitors' reporting along with the outstanding information given by the astronaut permitted assessment of the astronaut easily without special queries and extra messages to the station. The data indicating the reliable performance of the environmental system complemented the general assessment that the astronaut was in excellent condition. The consistency of report on the blood pressure was an excellent indication of the range station support since the stations had had little experience with this instrument before. The only remaining range station problem is the pulse and respiration rate counters. The GSC is working on the solution of this problem presently.

Stanley C. White, M.D.
Chief, Life Systems Division

SCW:th

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
February 22, 1962

MEMORANDUM for Flight Director

Subject: Postlaunch Report on Test 5460
Location: Mercury Control Center
Position: Retrofire Controller
Date: February 20, 1962

1. This position was manned at approximately 03:30 EST.
2. Communication checks were made at about 04:00 EST. All checks were good with the exception of full period seven, which was not patched up at this time. The net (FP 7) was established at about 05:00 EST.
3. Preliminary trajectory confidence checks were conducted at about T-175. One run checked GE/Burroughs data by use of a tape from Burroughs and the other run was the standard T-175 line IP 7090 run. The results of these test are given in Tables I and II respectively. All displays were active and correct.
4. MCC command confidence checks were commenced at about 09:12Z. These checks were all good.
5. The display confidence tape check was made at 09:33Z. The retro-sequence setting read 01:35:10 which is correct. The CET was read at 01:49:30 and counting with all digits holding steady. From this position the confidence tape check was very good.
6. A hold was called at about 10:30Z to replace GE rate beacon and because of astro helmet mike support difficulties. The count was resumed at 11:25Z.

7. The T-75 trajectory confidence check was conducted on schedule. The results of this test are given in Table III. All displays were again active and correct. The MSC computer and LMAL computer supported this run and the results from these computers agreed with the GSFC results to within one (1) second. The order wire drill was performed during this test and was very successful.

8. Another hold occurred at T-60. Count was picked up at 13:05Z.

9. A successful data flow check was started at 13:10Z.

10. The prelaunch checklist was monitored at 13:20Z (T-45). The capsule clock GMT was 13:22:25 as compared to ground GMT of 13:22:24. Retrosequence time read 04:32:28 both in the capsule and on the ground.

11. A hold was called at T-45 for fuel topping and gantry removal. Astro reported the capsule attitudes as -

Roll	0 deg.
Yaw	180 deg.
Pitch	90 deg.

The count was resumed at 13:35Z.

12. At T-22 another GMT time hack was obtained from astro upon my request. The capsule GMT was 13:57:45 and the ground GMT was 13:57:44.

13. The BDA computer lost power. A short hold was called and count resumed at 14:41Z.

14. The count continued on down to liftoff. Communications were good throughout this part of the count. At liftoff the capsule clock started as planned and ran continuously throughout the mission. All readouts were correct and steady. All other console displays were active and correct throughout the mission. All data recorded during the mission is given in

Table IV and Table V. Table IV has all the data obtained from GSFC and Table V has the data obtained from MSC and LMAL.

Communications with BDA during launch were good. Communications with the complete network were excellent for entire mission. The only communication difficulty occurred on FP 7. The receive capability on this line at GEB was intermittent after the beginning of the second orbit. There was no difficulty at anytime between this position (MCC) and MSC computers. The trouble at GEB was traced to faulty headset jacks.

The computed retrosequence times from GSFC, MSC and LMAL agreed within 1 or 2 seconds. (See Tables IV and V) The retrosequence time was different from that set in the capsule by 19 seconds at cut-off. Differential correction on BDA data reduced this to 10 seconds. The CYI data increased the difference to 14 seconds; MUC reduced it to 12 seconds, U.S.A. data reduced it to 11 seconds during the first orbit. After passing the U.S.A. at the end of the second orbit the difference was reduced to 10 seconds and remained at this value thereafter. The astro reset the capsule clock over CNV at the end of the second orbit and then reduced the setting one second over HAW near the end of the third orbit. The ground readout verified the correct setting.

The capsule clock appeared to be running correctly at CNV LOS. Some stations reported the clock one second slow during the first orbit and most stations reported the capsule clock one second slow during the second and third orbits. (See Table IV) This difference was taken into account in resetting the clock over HAW. The clock setting readout as reported by all stations was correct at all times.

The retrosequence and retrofire countdown was given over GSFC conference loop and relayed to astro by California Capcom. All retro events appeared to have occurred on time and in the proper sequence. The CAL station reported the D.C. current pegged at 04:33:09, retro two light at 04:33:20, and retro three light at 04:33:25. The time difference between retro one fire and retro one light is about six (6) seconds and this indicates the proper firing interval.

15. The order in which data was received from GSFC and MSC is given in Table VI. The data that was sent out to the network is also indicated. This Table gives some indication of the importance of the real time support supplied at MSC. It also indicates that the GSFC computer logic is not correct insofar as the time at which the retrosequence times for specific recovery areas are computed. It also shows that flexibility is lacking in that retrosequence times for non-standard landing longitudes are obtained from MSC. At present, these non-standard computations can be done on the "C" computer at GSFC, but this option was not exercised during this mission. The "C" computer is used for other calculations during mission time.

16. The retrosequence times were relayed to the network via preadvisory messages. The times the messages were sent are compared to the planned times in Table VII. In general all data was transmitted on or prior to the planned time. Area 1C, 1D, 1E and 2C were transmitted somewhat later than planned but were relayed by voice ahead of the necessary on station time.

17. The command times and best function times were obtained from the Network Status Monitor and were as follows:

	<u>Cmd on</u>	<u>Cmd off</u>	<u>Best Function Time</u>
1st orbit	01:33:00	01:38:00	01:33:30 - 01:37:40
2nd orbit	03:06:00	03:12:00	03:07:00 - 03:11:00

At 01:34:30 time monitor report capsule command receiver signal strength at 15 microvolts and at 01:35:10 at 30-40 microvolts. These values are well above the threshold level. During the second orbital pass the signal strength was reported as 50 microvolts at 03:08:00, also well above the threshold level.

18. The range safety limits as reported by the RSOB were as follows:

	<u>Geocentric</u>		<u>Geodetic</u>
AZUSA	30.15 N	25.4 W	30.32 N
	29.46 N		29.63 N
		295.4 sec.	
FPS-16	31.08 N	28.6 W	31.27 N
	29.71 N		29.9 N
		294.75 sec.	

Time limits 281 - 313 seconds

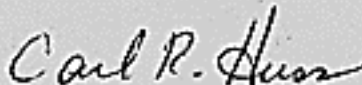
19. It appears, based on results and observations obtained during the mission at this position, that the follow statements can be made:

- a. The capsule clock kept good time, apparently losing only one second of time during the mission.
- b. The TM readouts concerning the capsule clock were correct and steady at all times.
- c. The capsule clock responded correctly to changes in retro-sequence setting made by the astronaut.
- d. All displays at this position were active and correct. MSC and GSFC computations agreed within one or two seconds.
- e. All retrosequence data was transmitted to the network in sufficient time to be used and relayed to the astronaut.
- f. Voice communications were satisfactory prior to and during the mission.

g. All procedures and data recording forms were proper and adequate.

20. It is recommended that the GMT and GET displays be interchanged at this position for easier comparison with CET. (This is being implemented); that the prelaunch weather briefing be continued; that the time monitor continue to report capsule command signal strength; and the MSC - LMAL computer support be maintained until the GSFC program logic is changed to allow the necessary flexibility. It is believed that all other flight control procedures utilized at this position are proper and adequate.

Support from all personnel was excellent prior to, during, and after this mission.



Carl R. Huss
Retrofire Controller

Encs:
Tables I thru VII

CRH:cjh

TABLE I

BURROUGHS TAPE RUN

MERCURY ATLAS
RECORD OF DATA OBTAINED DURINGTEST NO. 5460 MA 6BOOSTER NO. 109 D CAPSULE NO. 13DATE February 20, 1962

GMTS 13:45:30 ECTRS 04:32:28

GMT L.O. 09:13:02 CNV00:06:00 ΔT_R :14:25

GMTXO 09:19:02 GMTRC 09:32:30

ECTRC : :
ICTRC : :
AREA

	PRIMARY	GET	GET
CNV			
BDA			

CUT-OFF CONDITIONS

V/VR 1/

CNV

BDA

	END OF ORBIT	END OF MISSION	CONTINGENCY	AREA
GMTRC	104158	134549	093211	
ECTRC	012856	043247	001909	1B
ICTRC			04-13-19	

TABLE II

T-175 CHECK
LIVE IP 7090MERCURY ATLAS
RECORD OF DATA OBTAINED DURINGTEST NO. 5460 MA 6BOOSTER NO. 109 D CAPSULE NO. 13DATE February 20, 1962GMTRS 13:34:59 ECTRS 04:32:28
Liftoff about 2 secs. late

GMT L.O. 09:02:30

00:06:00

 ΔT_R 11:49

GMTXO 09:08:30

GMTRC 09:19:27

ECTRC : :

ICTRC : :

AREA 1B

	PRIMARY	GET	CET
CNV			
BDA			

CUT-OFF CONDITIONS

V/VR γ λ

CNV

BDA

	END OF OREIT	END OF MISSION	CONTINGENCY	AREA
GMTRC	103055	133429	091910	
ECTRC	012824	043158	001639	1B
ICTRC			-04-16+11	

TABLE III

T-75 CHECK
IP 7090MERCURY ATLAS
RECORD OF DATA OBTAINED DURINGTEST NO. 5460 MA 6BOOSTER NO. 109 D CAPSULE NO. 13DATE February 20, 1962GMTS 16:42:29 ECTS 04:32:28GMT L.O. 12:10:01 CNV BDA00:06:00 ΔT_R 11:52GMTXO 12:16:01

GMTRC

12:26:59

ECTRC : :

00:17:25

ICTRC : :

AREA 1B

1B

CNV

PRIMARY

GET

CET

BDA

CUT-OFF CONDITIONS
V/VR δ VAVE

CNV 1.0004 0.049 25730

BDA

SOURCE LAT LONG SOURCE LAT LONG

TABLE III concluded

T-75 CHECK

MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO. 5460 MA 6
 BOOSTER NO. 109 D CAPSULE NO. 13
 DATE February 20, 1962

COMPUTER RECOMMENDED VALUES

RETROSEQUENCE TIMES

GMT L.O. 12:10:01

	END OF ORBIT	END OF MISSION	CONTINGENCY	AREA	COMMENTS	EGT OR GMT
GMTRC ECTRC	133825 012824	164159 043158	122640 001639 -04-16+11	1B	GSFC Insertion	
	133831 012830	164206 043205	122726 001725 -04-15-03	1B	GSFC on BDA	
	133824 012823		130111 005110	1D	MSC on CNV	
			132607 011606	1E	MSC on CNV	
			124251 003250 -04+00+22	1C	Auto Update	
		164207 043206	132557 011556	1E	MSC on BDA	
	133830 012829		130118 005117	1D	MSC on BDA	

TABLE IV

MERCURY ATLAS
RECORD OF DATA OBTAINED DURINGTEST NO. 5460 MA 6BOOSTER NO. 109 D CAPSULE NO. 13DATE February 20, 1962

GMTS 19:20:07 ECTRS 04:32:28

GMT L.O. 14:47:39

00:06:00

CNV
Tr 00:12:58BDA

GMTXO 14:53:39

GMTRC 15:05:46

ECTRC : :

00:16:40

00:17:30

ICTRC : :

AREA 1B

1B

1B

CNV

BDA

PRIMARY

GET

CET

ERROR

LAUNCH 00:05:30 00:05:30 00

FIRST 01:35:00 01:34:59 -01

ORBIT 01:37:00 01:36:59 -00.5

SECOND 03:12:14 03:12:13 -01

ORBIT

CUT-OFF CONDITIONS

V/VR

 γ h V_{AVE} γ_{AVE} h_a

CNV 1.0002

-.07

86.4

25727

-.067

137.1

BDA

TABLE IV

MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO. 5460 MA 6
 BOOSTER NO. 109 D CAPSULE NO. 13
 DATE February 20, 1962 SOURCE GSFC

COMPUTER RECOMMENDED VALUES
RETROSEQUENCE TIMES

GMT L.O. 144739

	END ORBIT	END OF MISSION	CONTINGENCY	AREA	COMMENTS	EGT
GMTRC	161633	192026	150529	1B	GSFC	
ECTRC	012854	043247	001750		ON	
ICTRC			-04-15+22		CNV	
	161627	192017	150511	1B	GSFC	
	012848	043238	001732		ON	
			-04-15+04		BDA	
			151951	1C	AUTO.	00:17:00
			003212		UPDATE	
			-04+00-16			
	161629	192021	151943	1C	AUTO.	
	012850	043242	003204		UPDATE	
			-04 00-24		ON CYI	
			153758	1D	AUTO.	
			005019		UPDATE	
			-04+18-09			00:29:00
			160320	1E	AUTO.	
			011541		UPDATE	01:00:00
			-03-17+13			
	161629	192020	160321	1E	AUTO.	
	012850	043241	011542		UPDATE	
			-03-17+14		ON MUC	
		192019			2ND D.C.	
		043240			ON MUC	
			162417	2A	AUTO.	
			013638		UPDATE	01:13:00
			-03+04+10		ON WOM	
	174820				AUTO.	
	030041				UPDATE	01:26:00
			163739	2B	AUTO.	
			015000		UPDATE	01:33:00
			-03+18-28			

TABLE IV (Cont'd)

MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO. 5460 MA 6
 BOOSTER NO. 109 D CAPSULE NO. 13
 DATE February 20, 1962 SOURCE GSFC

COMPUTER RECOMMENDED VALUES
RETROSEQUENCE TIMESGMT L.O. 144739

	END OF ORBIT	END OF MISSION	CONTINGENCY	AREA	COMMENTS	EGT
GMTRC	174818	192018			AUTO	
ECTRC	030039	043239			UPDATE	
ICTRC						
			165339	2C	AUTO	
			020600		UPDATE	01:48:00
			-02-26-28			
			172608	2D	AUTO	
			023829		UPDATE	02:03:00
			-02+06+01			
	174818	192018	172609	2D	AUTO	
	030039	043239	023830		UPDATE	
			-02+06+02		ON MUC	
			173637	2E	AUTO	
			024858		UPDATE	02:35:00
			-02+16+30		ON WOM	
			175904	3A	AUTO	
			031125		UPDATE	02:45:00
			-01-21-03			
		192018			AUTO	02:58:00
		043239			UPDATE	
			181011	3B	AUTO	
			032232		UPDATE	03:09:00
			-01-10+04		HAW	
		192017			AUTO UP-	
		043238			DATE WHS	
		192017	181013	3B	AUTO	
		043238	032234		UPDATE	
			-01-10+06		CNV	
			182756	3C	AUTO	03:19:00
			034017		UPDATE	
			-01+08-11			
			190011	3D	AUTO	
			041232		UPDATE	03:37:00
			00-20-06			
			190950	3E	AUTO	04:09:00
			042211		UPDATE	
			00-10-27			
	204243			120 W	AUTO	04:29:00
	055504			4TH ORBIT	UPDATE	

TABLE IV (Cont'd)

ORBIT ONE

MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO.	5460	MA	6
BOOSTER NO.	109 D	CAPSULE NO.	13
DATE	February 20, 1962	GMT L.O.	144739
FROM SUMMARY STATION	ECTRS	ECT-EGT ERROR	ERROR RATE
RECOMMENDED SETTING			
CNV	043228	0	043247
BDA	043228	0	043247
CYT	043228	0	043238
KNO	043228	0	043242
ZZB	043228	-01	043242
IOS	043228	-01	043242
MUC	043228	0	043241
WOM	043228	0	043240
CTN	043228	0	043240
HAW			
GYM	043228	-01	043239
CAL	043228	-01	043239
TEX	043228	-----	043239

TABLE IV Continued

ORBIT TWO

MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO. 5460 MA 6
 BOOSTER NO. 109 D CAPSULE NO. 13
 DATE February 20, 1962 GMT L.O. 14:47:39

FROM SUMMARY

STATION	ECTRS	ECT-EGT ERROR	ERROR RATE	RECOMMENDED SETTING
CNV	04:32:28	0		04:32:39
EDA	04:32:28	0		04:32:39
ATS	04:32:28	-01		04:32:39
CYI	04:32:28	-01		04:32:39
KNO	04:32:28	-01		04:32:39
ZZB	04:32:28	-01		04:32:39
IOS	04:32:28	-01		04:32:39
MUC	04:32:28	-01		04:32:39
WOM	04:32:28	-01		04:32:39
CTH	04:32:28	00		04:32:39
HAW		-01		04:32:39
GYM	04:32:28	-01		04:32:39
CAL	04:32:28	-01		04:32:39
TEX	04:32:38	-01		04:32:38

TABLE IV concluded

ORBIT THREE

MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO. 5460 MA 6
BOOSTER NO. 109 D CAPSULE NO. 13
DATE February 20, 1962 GMT L.O. 14:47:39

FROM SUMMARY				
STATION	ECTRS	ECT-EGT ERROR	ERROR RATE	RECOMMENDED SETTING
CNV	04:32:38	-01		04:32:38
BDA	04:32:38	-01		04:32:38
ATS	04:32:38	-01		04:32:38
IOS	04:32:38	-01		04:32:38
MUC	04:32:38	-01		04:32:38
WOM	04:32:38	-01		04:32:38
HAW	04:32:37	-01		04:32:38
GYM	04:32:37	-01		04:32:38

TABLE V

MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO. 5460 MA 6
 BOOSTER NO. 109D CAPSULE NO. 13
 DATE February 20, 1962 SOURCE MSC

COMPUTER RECOMMENDED VALUES

RETROSEQUENCE TIMES

GMT L.O. 14:47:39

	END OF ORBIT	END OF MISSION	CONTINGENCY	AREA	COMMENTS	EGT OR GMT
GMIRC	16:16:32		15:37:57		MSC on	
ECTRC	01:28:53		00:50:18	1D	CNV	
ICTRC						
			16:03:15			
			01:15:36	1E	on CNV	
			16:03:21		on BDA	
			01:15:42	1E		
			-03:-17:+14			
	16:16:27	19:20:19	15:38:03		on BDA	
	01:28:48	04:32:40	00:50:24	1D		
			-04:+18:-04			
			16:07:23	98.5°W	on BDA	
			01:19:44	1st orbit		
			16:03:20	1E	on CYI	
			01:15:41			
			15:37:56	1D	On CYI	
			00:50:17			
			17:36:38			
			02:48:59	2E	on CYI	
			-02:+17:-29			
			16:37:39			
			01:50:00	2B	on CYI	
			-03:+18:-28			
	16:16:29		16:53:38			
	01:28:50		02:05:59	2C	on CYI	
			-02:-26:-29			
	17:48:21	19:20:22				
	03:00:42	04:32:43		G	on WOM	

TABLE V concluded
MERCURY ATLAS
RECORD OF DATA OBTAINED DURING

TEST NO. 5460 MA 6
BOOSTER NO. 109 D CAPSULE NO. 13
DATE February 20, 1962 SOURCE MSC

COMPUTER RECOMMENDED VALUES
RETROSEQUENCE TIMES

END OF ORBIT		END OF MISSION	CONTINGENCY	AREA	GMT L.O. <u>14:47:39</u>	COMMENTS	EOT OR GMT
GMTRC			17:26:10				
ECTRC			02:38:31	2D		on CYI	
ICTRC			-02:+06:+03				
			16:07:24	98.5°W		on CYI and	
			01:19:45	1st Orbit		WHS	
17:48:20				G		on WOM	
03:00:41							
				21°10'N		IP for	
				68°07'W		04:32:40	
			17:36:37				
			02:48:58	2E		on WHS	
			-02:+16:+30				
			18:10:15				
			03:22:36	3B		on WHS	
			-01:-10:+08				
17:48:18				G		on EGL	
03:00:40							
			18:27:57				
			03:40:18	3C		on EGL	
			-01:+08:-10				
			17:59:06				
			03:11:27	3A		on BDA	
			-01:-21:-01			and CYI	
	19:20:20		19:00:12				
	04:32:41		04:12:33				
			00:-20:+05	3D		on EGL	
			17:39:58	103°W		on BDA	
			02:52:19	2nd Orbit			
			19:09:52				
			04:22:13	3E		on BDA	
			00:-10:-15				
				21°06'N		IP for 04:32:41	
				67°58'W		on WOM	
			19:13:18	102°W		on CAL	
			04:25:39	3rd Orbit			
	19:20:19		19:13:19	102°W		on BDA	
	04:32:40		04:25:40	3rd Orbit			

TABLE VI
ORDER IN WHICH RETROSEQUENCE DATA WAS OBTAINED
AND DISPOSITION

AREA	SOURCE - VECTOR		AREA	SOURCE - VECTOR	
F	GSFC - CNV		G	MSC - CYI	
H	GSFC - CNV		H	MSC - CYI	
1B	GSFC - CNV	sent	2D	MSC - CYI	sent
F	GSFC - BDA	sent	98.5°W	MSC - CYI-WHS	sent
H	GSFC - BDA	sent	1E	GSFC	
1B	GSFC - BDA	sent	F	GSFC - MUC	sent
1C	GSFC - BDA	sent	H	GSFC - MUC	
1D	MSC - CNV		1E	GSFC - MSC	
F	MSC - CNV		H	GSFC - MUC	sent
1E	MSC - CNV		2A	GSFC - WOM	sent
1E	MSC - BDA	sent	G	MSC - WOM	sent
1D	MSC - BDA	sent	G	GSFC	
F	MSC - BDA		2B	GSFC	
H	MSC - BDA		G	GSFC	sent
1C	GSFC - CYI		H	GSFC	sent
98.5°W	MSC - BDA		2E	MSC - WHS	
1D	GSFC - CYI	sent	3B	MSC - WHS	sent
1E	MSC - CYI		G	MSC - EGL	
1D	MSC - CYI		3C	MSC - EGL	sent
2E	MSC - CYI	sent	2C	GSFC	
2B	MSC - CYI	sent	3A	MSC - BDA-CYI	sent
2C	MSC - CYI	sent	H	MSC - EGL	
			3D	MSC - EGL	sent

TABLE VI concluded

AREA	SOURCE - VECTOR	AREA	SOURCE - VECTOR
103°W	MSC - BDA	sent	
3E	MSC - BDA	sent	
2D	GSFC		
G	GSFC - MUC		
H	GSFC - MUC		
2D	GSFC - MUC		
2E	GSFC - WOM		
3A	GSFC - WOM		
H	GSFC		
3B	GSFC - HAW		
H	GSFC - WHS	sent	
3B	GSFC - CNV		
3C	GSFC		
102°W	MSC - CAL	sent	
H	MSC - BDA		
102°W	MSC - BDA		
3D	GSFC		
3E	GSFC		
102°W	GSFC		

TABLE VII

PAD MESSAGE SUMMARY

TRANSMISSION TIME:Z	TYPE OR AREAS	PLANNED TRANSMISSION TIME:Z
14:52	V/V _R for radar plotboard altitude	-----
14:55	1B	15:00
15:07	1C, F, H	15:05
15:16	1D, 1E, F, H	15:07, 15:12
15:17	98.5 deg. W. long.	-----
15:18	1D	15:07
16:01	2A, 2B, F, H	16:02
16:04	2D, 2E	16:37
16:05	2C, G	16:02
16:38	G, H	-----
16:54	103 deg. W. long.	-----
17:24	3A, 3B	17:33
17:31	3C, 3D	17:33, 18:17
17:37	CET 1 sec. slow	-----
18:07	3E, H	18:17
18:12	102 deg. W. long.	-----

NASA - Manned Spacecraft Center
Langley Station
Hampton, Virginia
March 27, 1962

MEMORANDUM for Flight Director

Subject: Postlaunch Report on Test 5460

Location: Mercury Control Center
Position: Capsule Environment Monitor
Date: February 20, 1962

1. Prelaunch.- The only problem encountered in the prelaunch period was an increasing 150 v-amp inverter temperature. This appeared to stabilize at 165° F. during the last hour of the count and indicated 167° F. at lift-off. Freon flow cannot be regulated to individual components, and since the astronaut reported that he was cool, no attempt was made to increase the flow rate beyond 35 lb/hr to cool the inverter.

Spacecraft no. 13 was equipped with a constant-bleed orifice which supplied the suit circuit with oxygen whenever the 7,500 psi supply valves were open. The four and one-half hour period between the opening of these valves and launch permitted a good determination of the usage rate, which indicated between four and five percent per hour decay of the primary supply.

The suit and cabin purge analyses both indicated 99 percent oxygen. The cabin leakage rate was too low to be measured with the quick decay test made on the gantry, but was estimated to be less than 500 cc/min (19.7 psia and 70° F.) or 1.96×10^{-3} lb/min.

2. Launch.- The cabin and suit pressure transients observed during launch were normal. Both followed static pressure with a 5.5 to 6.0 psi differential. The cabin pressure appeared to hold at 6.1 psia and the astronaut reported this value before it had stabilized on telemetry. Cabin pressure had slowly decreased to 5.9 psia at LOS and was steady. No other changes in ECS parameters were noted during the launch phase.

3. Orbit.- Suit inlet temperature indicated 68° F. at launch and remained below 74° F. until the inflow valve opened on descent. At this time, the temperature increased rapidly and was 86° F. when telemetry was turned off after impact. The writer did not receive messages from other sites relating the position of the suit comfort control valve.

Capsule Environment Monitor Report - continued

- 2 -

Although this data was not requested, the onboard voice tape indicates that the astronaut reported flow rates in excess of 1.7 lb/hr. A briefing message which gave the expected valve settings was transmitted to all sites prior to launch. Such a large deviation should have been recognized and reported.

The cabin temperature varied between 90° F and 104° F during the orbital phase. Since cabin cooling is a recognized problem area, the values encountered in the MA-6 mission are considered tolerable.

Although the 250 v-amp inverter temperature was satisfactory at launch, (120° F.) it increased steadily during the flight to a maximum value of 202° F. The 150 v-amp inverter temperature peaked at 212° F.

The values quoted above are from the onboard tape, although real-time data received from the network indicated higher temperatures. Postflight tests revealed a stuck check valve in the water supply line, which is common to both inverter cold plates. This malfunction satisfactorily explains the lack of inverter cooling.

Oxygen usage from the primary supply was identical to that indicated during the prelaunch period, namely four to five percent per hour. The secondary oxygen supply exhibited an unexplained decay, commencing with Kano on the second pass. A definite rate was not established until after the decision to go for the third orbit had been made. No explanation for this usage is available at this time. Postflight tests revealed no leakage in the system.

4. Reentry.-- No problems were indicated during reentry. The maximum cabin temperature was 103° F., which was less than the peak value observed during the orbital phase.

5. Summary.-- Certain items of information pertaining to the ECS are revealed on the onboard voice tape which were never reported to MCC. These include the excess cabin-water warning light, the open-visor operation for an extended period, and the previously discussed suit comfort valve setting of 1.7 lb/hr. Any deviations from the normal system values are necessary for proper evaluation during flight.

Capsule Environment Monitor Report - concluded

- 3 -

It is recommended that the flight plan be modified to include any such deviation in the standard station report, and that such deviations be transmitted to MCC.



Frank H. Samonski, Jr.
Capsule Environment Monitor

FHS:jps

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
February 27, 1962

Subject: Report on Test 5460 (MA-6)
Location: Mercury Control Center
Position: Flight Director
Date: February 20, 1962

This report is primarily the chronological description of the flight from lift-off to landing. It will present the results of the flight as determined in real time. It is recognized that the results may be different from those presented in other sections of this report and future detailed analysis made of the data obtained; however, the flight test results included herein were the basis for the flight control decisions made during the flight.

No discussion is given of the events leading up to the launch; however, it should be noted that in the previous report it was recommended that the same procedures be followed in preparation for the MA-6 flight and this was carried out, even to the point of scrubbing the first attempted launch. Again the flight control simulations which were performed proved to be invaluable in training not only the flight control team, but the astronauts themselves. The usefulness and need for simulated flights previous to the launch cannot be overemphasized and it is recommended that they be continued for all future flight operations. A brief summary of the flight test is as follows:

The launch and insertion into orbit was considered to be about perfect. The orbit achieved was completely nominal and the sequence times and times for all other events were within a very few seconds of those predicted before the flight. The astronaut's performance throughout the flight was excellent, and he seemed to have no problems which he could not cope with throughout the flight. Several problems developed in the automatic control system. The ASCS system was unable to maintain the capsule in orbit mode in the yaw axis after approximately one orbit. This same malfunction was reflected in the fly-by-wire system. The horizon scanner and gyro reference system appeared to be in error while the capsule was on the dark side of the earth. This was mainly in evidence in the roll axis. The manual proportional system worked well throughout the flight. The cooling system for both main inverters appeared to be inoperative throughout the entire flight and the inverter temperatures reached values as high as 210° to 220° F; however, no malfunctions occurred.

In the first pass over Canaveral, Segment 51 of the commutator showed an 80 percent value which, if correct, indicated that the landing bag had been deployed. A great deal of analysis and discussion followed and a decision was first made that the signal, although a correct telemetry output, was the result of a faulty micro switch and that the normal sequence of events should be followed. Further discussion, however, indicated that the safest approach to be taken would be to allow the retropackage to remain on such that the retropackage straps would hold the heat shield in its proper position until sufficient dynamic force was exerted on the shield to maintain its position throughout reentry heating. The expert opinion was that the heat affects of the retropackage on the capsule heat shield and afterbody would not be damaging. Therefore, the astronaut was redirected during the retrofire maneuver over CAL to keep the retrojettison switch in the disarm position. The results of the test, of course, proved this to be a sound decision. The remainder of the flight was nominal and no other major system malfunctions occurred. It might be noted that many of the trends exhibited in this flight were identical to those obtained from MA-5. It must be strongly emphasized that although the malfunctions which did occur were minor with an astronaut in the capsule, these malfunctions would have made an unmanned flight extremely difficult to handle and may well have resulted in the inability to reenter the capsule and obtain successful recovery.

The following paragraphs present a chronological description of the flight test from lift-off to landing.

The lift-off and the entire powered phase of flight was completely normal and neither the astronaut nor the capsule systems showed any anomalies. The communications procedures proved to be adequate and no problems were encountered. The only minor discrepancy was the indication of horizon scanner ignore signals previous to tower separation which have been experienced in previous flights. The sustainer cutoff was excellent and no trouble was experienced in making the GO-NO-GO decision. The capsule separation and turnaround maneuver were as expected and the astronaut made a number of comments such as observing the tumbling booster and the tremendous view available to him.

The BDA site reported the astronaut to be in continuing GO condition and in the process of performing the scheduled control systems checks at the time of LOS. The air-to-ground patch to the Goddard conference net at the CYI allowed all voice sites to read the radio transmissions from the astronaut loud and clear. This condition existed throughout the flight and was extremely useful and valuable in maintaining real time surveillance of the flight. The CYI reports indicated that the control systems checks had been completed and were all in perfect working order. The astronaut continued to be in excellent condition and noted he was very comfortable. He reported that the horizon was a brilliant sight, that he had a beautiful view of Africa and the CYI both from the window and the periscope, but that the view

from the window was superior. The astronaut remained on the ASCS system throughout the pass and all capsule systems were functioning properly.

All of the sites between CYI and MUC were in contact with the astronaut and all of the capsule systems continued to function properly. The astronaut performed the 60° yaw maneuver on the fly-by-wire system over KNO and reported the fly-by-wire performance to be excellent in all axes. He also reported being in excellent condition and noted that he had taken the xylose tablet as planned. The only problem at this time appeared to be the increasing temperature; however, the trend was identical to the MA-5 flight and caused no concern since the astronaut reported being very comfortable. Also, no major discrepancies between the astronaut and ground readouts were in evidence. There was a difference in all of the readings, but this was to be expected.

Over ZZB the astronaut gave his first 30-minute report and reported no problems with such tests as visual acuity or stigmatism, and negative results from such things as affects from head movements, reaching, touching, etc. Teletype reports from the IOS indicated the astronaut was very much impressed with the sunset which he described as beautiful, that the sky above was black but that there was a thin band of blue remaining along the horizon. He also reported some stars were visible but that no constellations were identifiable. Also, he reported no affects from weightlessness and that his condition was excellent. Due to high winds, the IOS was unable to launch the balloon flares which had been planned; however, they did carry out the firing of a mortar flare, but the astronaut did not report any firing of such flares. It is probable that this flare was not visible because of the partly cloudy conditions.

Both HF and UHF contacts were made when expected by MUC and again it was possible to read the air-to-ground transmissions to and from the astronaut loud and clear on the Goddard conference net. Upon contact, the astronaut reported all systems were good and, in particular, the control systems were operating well. He reported that he could see stars above and clouds below while in darkness, especially the moon shining on the clouds below. He also noted an unusually high haze layer about 7° to 8° above the horizon and noted that a great deal of Africa was covered with clouds, but that this had thinned out as he traveled over the Indian Ocean. The astronaut reported seeing a big pattern of lights on the coast and could also see lights inland and that these lights were very clear. After contact with WOM, the astronaut again proceeded with a standard 30-minute report and the results of this report again showed the astronaut to be in excellent condition, negative results from head movements, etc., and that all capsule systems were normal. In addition, two blood pressure measurements were made over the WOM site. The lights from WOM were not visible because of the cloudy conditions. The WOM CapCom and aeromedical report following LOS confirmed the astronaut's reports.

The CTN site reported by teletype that the astronaut had had no difficulty in eating, that he was following the flight plan and that everything remained in good condition. It was at this site that he first reported seeing the small luminous particles moving at approximately the same speed as the capsule and that these particles were brilliantly lit up by the sunrise.

The GO-NO-GO decision for a second orbit was discussed with GYM by MCC and it was agreed that unless the astronaut or GYM noted any major changes from the present situation everything was GO for another orbit. Upon contact with the astronaut, all systems proved to be in a GO condition and GYM and the astronaut made the GO decision for the second orbit. The astronaut continued to be impressed by the luminous particles floating around the outside of the capsule and reported this to be the only unusual or unexpected event. He reported that he had been taking pictures and the normal transfer of information between the astronaut and the GYM CapCom took place. He also reported a great deal of cloud cover and that he could not see land. Midway during the pass over GYM the astronaut reported that the capsule was drifting in yaw while on the ASCS but was being restored when the capsule reached about 20° right yaw. This report indicated that the ASCS was not able to maintain orbit mode in the right yaw direction but that the orientation mode was operating satisfactorily. This same report was made to the Control Center and MCC recommended that he stay on the fly-by-wire system rather than use ASCS to conserve auto fuel (of course, the astronaut was well aware of this situation and had already taken such action); however, although the astronaut reported no trouble in the fly-by-wire system, a close examination of the data at MCC after the flight indicated that the 1-pound left yaw thruster was not actuating and that only the high thruster operation was positive. Therefore, it is probable that the 1-pound thruster in left yaw was inoperative on both systems.

The Control Center also commanded R and Z Cal and the calibrations corrections were insignificant. This disagreed with the R and Z Cal obtained by MUC during the first orbit. There is at this time no explanation for this difference. The astronaut made his normal 30-minute report to MCC and made some of the previous comments that he had made to other sites regarding his observations. He also reported having a beautiful view of the coast and across Florida. He transferred his communications to BDA and continued his reporting and noted that there were no affects of weightlessness as measured by the oculogyric test.

During the pass over CNV the analysis by the Control Center monitors indicated the astronaut to be in excellent condition and that all systems other than those mentioned were operating satisfactorily. At this time in the flight the 150-VA inverter temperature was approximately 200° but it was felt that the rate of rise

was small and that based on tests made in the past few minutes, no immediate inverter problem existed. It was also noted that the 250-VA inverter temperature had increased to about 180° indicating that the cooling system for both inverters was not functioning properly.

The oxygen usage rate on the primary oxygen supply appeared to be about 4 percent per hour as had been measuring during prelaunch tests. The secondary oxygen supply was remaining at 100 percent. The entire environmental control system appeared to be functioning perfectly. The fuel usage rates gave no concern at this time and the peroxide temperatures were well within limits and lower than expected. All of the other quantities being monitored on the ground were completely normal. The one exception to this was the notice over CNV that Segment 51, landing bag deploy, indicated that this event had occurred. This fact, of course, later resulted in much discussion analysis and necessitated a rather profound decision to be made.

The CYI was asked to query the astronaut regarding correlation of the hydrogen peroxide jets and the particles which he had been observing. The astronaut felt that there was no correlation between the two. Over the CYI the astronaut reported the fly-by-wire status to be excellent. He also reported seeing the Cape Verde Islands and he had no trouble controlling, using the horizon as a visual reference and noted that he could feel the warmth of the sun shining through the window on his suit and that he remained very comfortable.

The MCC obtained voice contact with the ATS on single side band radio and they reported that the ASCS problem in right yaw had cleared and was now reversed, and the capsule was drifting in left yaw. The ATS reported that the astronaut had completed the 180° yaw maneuver and that he was pleased with the view from this position. He also reported a bolt floating in the cabin and that all other systems, other than the control systems, were OK.

A teletype report from KNO confirmed the astronaut's problem on ASCS and indicated he was drifting from the flight plan in order to check out the yaw control problem. KNO also reported intermittent pitch and roll ignore signals and that the telemetry readouts indicated the correct orbit attitude when in ASCS, but that the astronaut was doubtful about his yaw attitude. ZZB also reported and confirmed the ASCS condition and noted that the astronaut had pulled the manual proportional handle. During this period, the Control Center discussed the control system problems with MUC and asked that they query the astronaut to assure that the fly-by-wire and manual proportional systems were still operating properly. Also, a teletype message was sent out from the Control Center describing the problems which could exist if the landing bag deploy signal was a valid one.

During the pass over MUC, the astronaut reported that he was on manual control and that he was having erratic indications on his attitude instruments in all axes and that these instruments were considerably off in attitude, as compared to the horizon reference he had at that time. He indicated that he was not too concerned over this matter and would wait for daylight to further check these readings. He reported that the fly-by-wire system was not functioning in low right yaw but that both high thrusters were functioning properly in the yaw axis. All other axes were satisfactory. At the request of MCC, WOM asked that he make a gyro horizon check before reaching CAL and the astronaut confirmed he would do so. He also reported having no difficulty controlling on the manual system and that all other systems appeared to be performing properly.

Over Australia, the astronaut reported that the landing bag switch was off, that he could discern no banging noise when high rates were used. He also reported observing Orion clearly.

The astronaut again reported sighting thousands of small particles extending to the limit of his vision when over CTN. These particles were again visible at sunrise. CTN also noted that Segment 51 was reading zero during its pass. Upon contact with HAW, the astronaut reported that he had caged the gyros on the dark side at 000 attitude and was also performing the same check in the daylight. He reported that when he felt the capsule was aligned visually with the horizon as a reference, the roll attitude was off 20° in the right roll direction but that yaw and pitch appeared normal. The ground telemetry readouts of these quantities agreed approximately with those reported by the astronaut in pitch and yaw, but the ground readout of roll was 10° left roll when the astronaut reported 19° right. HAW was also requested to query the astronaut as to his feeling regarding the continuation onto the third orbit and he answered in the affirmative. The GO-NO-GO decision for making a third orbit was discussed between MUC and CAL and it was decided that if no further problems developed when they made contact with the astronaut, that MCC was prepared to go in the orbit. The CAL site reported that all three axes, as read out on the ground, agreed with the astronaut's readings, and it was felt that the capsule horizon reference system appeared to be operating satisfactorily after sufficient time in the daylight. The astronaut reported that he had very good visual reference in pitch and roll out of the window or the periscope, but that he felt his best yaw reference was primarily from the window by watching the drift of something moving away from him. During the pass over the TEX site, the astronaut pitched the capsule down to 60° to get a better observation of the United States.

Upon contact with the Control Center, a number of recommendations were made to the astronaut. He was directed to change the retrosequence time to 04:32:38 which he did (BDA had been previously requested by MCC to set up the clock change contingent on the astronaut's capability to reset the clock). He was advised to conserve fuel in the manual system even if it required allowing the capsule to drift to wide angles and that he was free to use the gyros in any manner which he saw fit, that is, either in the normal free or caged position. In discussion with the astronaut regarding the gyro reference system, both the ground and the astronaut agreed that the horizon scanner reference system appeared to function satisfactorily on the daylight side in that the visual references and gyro readouts now agreed and that the horizon scanner system was not functioning properly while on the dark side of the earth. While in contact with BDA, the astronaut reported to have Cape Canaveral in sight and that the whole state of Florida was laid out like a map, and that he could see as far back as the Mississippi Delta. The astronaut also concurred with the MCC recommendation that he use the ASCS for retrofire with manual backup.

After this particular pass over MCC, the following systems status were known.

The primary oxygen usage rate continued to be 4 percent per hour. A decrease in secondary supply was noted (92 percent) and gave rise to the possibilities of an oxygen leak in the system. Both inverters had reached about 200° F but showed no tendency to rise to a much greater temperature. The astronaut's body temperature had shown a steady rise from lift-off of about 98° to about 99° at this time. The suit inlet temperature appeared to have stabilized at about 72° and the cabin air temperature had stabilized at about 100°. The suit, cabin, and O₂ partial pressures remained constant. The fuel line temperatures were still well within limits and remained lower than expected. The auto fuel quantity was 60 percent and the manual fuel quantity was also 60 percent. All other measurements indicated normal readings. The only known problems of major concern at this time were the lack of yaw control in orbit mode on the ASCS and similar problems in yaw on the fly-by-wire system, the problems encountered with gyro reference on the dark side of the earth, the desire to conserve manual fuel and reentry, and the continued gnawing problem of power to interpret and what to do about the telemetry indication of landing bag deploy.

The astronaut's physical condition remained excellent and his ability to maintain control of the capsule was never in doubt. The CYI did not receive telemetry reception on the third orbit but did have HF contact which was loud and clear. The astronaut reported that he still felt in excellent condition and that he remain on manual control. He also reported that he had seen no more particles but that he had seen them each time at sunrise.

Over the ATS, the astronaut again reported having trouble between gyro attitude outputs and his visual reference, and that he had returned to 000 and caged the gyros. He then returned the gyros to normal and went on the ASCS. The exact interpretation of this message was hard to decipher and the Control Center asked MUC to further query the astronaut on this situation. The Control Center also directed MUC to have the astronaut reset the clock to 04:32:37 (the desired GET setting was 04:32:38 at this time but it was known that the clock was slow by 1 second). The control system action following retrosequence was also discussed with MUC to assure that the astronaut was aware that the high torque jets would be continually functioning after retrosequence command.

During this period, the significance of the telemetry signal of Segment 51 was being thoroughly analyzed and much discussion ensued. A number of capsule systems experts were called in to this discussion in an effort to determine the best course of action. It was very difficult to obtain a decision on this matter because of the significant effect that this occurrence (landing bag deploy) could have on the mission. Two courses of action were available. First, that the micro switch from which the signal is obtained had failed and was giving a spurious reading in which case the normal reentry sequence would be followed. Secondary, that the landing bag deploy circuit had, in fact, been actuated, i.e., the squibs fired and the mechanism initiated, and that the retropackage straps were maintaining the heat shield in the closed position. If this be the case, then it would be preferable to allow the retropackage to remain on the heat shield after retrofire and during the reentry in order to assure that the heat shield would remain attached to the capsule bulkhead until sufficient dynamic pressure was achieved during reentry to maintain the shield in this position. The danger here, of course, was the unknown effect that the retropackage, and in subsequent deformation due to heating, would have on the heat shield or other portions of the capsule structure.

The IOS reported that the astronaut remained in excellent condition and that all systems, except for ASCS and FBW, were operating satisfactorily, although the O₂ secondary quantity had dropped to 90 percent indicating possible continued oxygen leakage from this system. The ASCS problem continued to show itself by a drift in the yaw axis and the astronaut reported no low thrust in right yaw. The astronaut confirmed the same inputs regarding control system problems to MUC and some discussion was held on a message to the Commandant of the U.S. Marine Corps noting that John Glenn had made 4 hours flight time for the month. He continued his 30-minute report noting that all systems continued to be OK and that the landing bag switch was off. The MUC CapCom and the astronaut discussed the method of control during retrofire and the astronaut reported that he would use ASCS if the gyro reference system appeared to be functioning properly, otherwise he would use the manual proportional system for retrofire. He also

noted that he would try to realine the gyros shortly to determine if they were operating satisfactorily. The astronaut was directed by MUC on two occasions to change the clock setting to 04:32:37 but this was not accomplished over this site. (It might be noted that all sites continued to report Segment 51 as 78 to 85 percent full scale.) WOM had short contact during the third orbit, but no additional information that was not known was obtained.

In an effort to obtain further information on the validity of the signal on Segment 51, MCC requested that HAW direct the astronaut to put the landing bag deploy switch to the auto position. They were further directed that if no light appeared, i.e., either green or red, that the astronaut was to use the normal reentry procedure. If the light were to appear, the astronaut should be directed to leave the package on during the reentry portion of the flight. When the astronaut first made contact with HAW, HAW noted to him that MCC had asked that he put the landing bag deploy switch to the auto position and determine its results. The astronaut was somewhat hesitant but did as directed and determined that with the switch in the armed position, no light was visible. He then put the switch back in the off position and continued on with the standard report and going through the retrosequence checklists. He reported that he was in ASCS mode and that although he originally appeared to be out in yaw, that the ASCS was beginning to correct properly in the yaw axis. He was also directed by HAW to change the clock to 04:32:37 which he acknowledged and proceeded to do.

Just previous to and following contact at HAW, the Control Center was continuing its efforts to determine the proper course of action to follow regarding whether to jettison or maintain retropackage. Based on the tests performed by the astronaut over HAW, it was originally decided to follow the normal sequence. However, continuing discussion and inputs from both NASA and McDonnell engineers reversed this decision and the final decision was made to reenter leaving the retropackage on after the retrofire maneuver.

Upon contact with CAL, there seemed to be some confusion on the astronaut's part as to the proper synchronization between ground elapsed and capsule elapsed time. However, the retrofire controller at MCC began to count down to retrosequence time, which was picked up by the CAL CapCom, and the retrosequence event occurred at the desired time of 04:32:38 GET (04:32:37 CET). During this same period, the MCC directed CAL to command the astronaut to leave the retrojettison switch in the off position and that reentry would be performed with the package remaining on the heat shield. The astronaut acknowledged this transmission. Firing of the retros took place at the proper time, as reported by voice from the astronaut, and both the ground and the astronaut reported that all three retros had fired. During the firing of the retrorockets, the astronaut

reported that he felt like he was going back to HAW and that the retro-attitudes were held fairly tightly during retrofire. This was confirmed by telemetry readout at the CAL station. It was apparent from the astronaut's radio transmissions that he was concerned about leaving the retropackage on during the reentry, but would do so as a result of the direction by MCC.

Since the normal sequence had been interrupted, that is, the retropackage was not jettisoned, it became necessary to manually retract the periscope and to override the 0.05g switch in order to bring about proper sequence during reentry. The MCC announced this over the Goddard conference net and the TEX station was able to get this message transmitted to the astronaut and he acknowledged that he would perform these manual overrides. A number of landing point predictions were obtained during this period and these will be described in detail in a later portion of this report.

After the astronaut was contacted by the MCC, he was given a briefing on the reasons for reentering with the retropackage still on the capsule. Very shortly thereafter, the capsule went into ionization blackout (4 hours, 43 minutes) and it was just after this period that the Cape CapCom recommended that he jettison the package after about 1 to 1.5g was achieved; however, it was doubtful that the astronaut received this transmission. About 2 minutes after the blackout period occurred, reports over continued C-band radar track were received indicating that the capsule was still OK and that 4 hours, 47 minutes, and 15 seconds the astronaut's voice was heard in a weak UHF transmission and several seconds later he indicated that he was OK and in good shape. He noted that the reentry was a real fireball. The Cape maintained contact with him continually from this point on and received both the drogue and main chute deploy reports from the astronaut and on telemetry. The astronaut reported the main chute to be in good shape and it was indeed a beautiful sight.

The astronaut continued to report that he was in good condition and desired information on recovery times, location, other information, etc. He also reported that it was a little hot in the capsule but that he had no immediate problems. During the descent of the parachute he was visually sighted by the Destroyer NOA and they began to work the capsule via radio. Almost all of the transmissions to and from the capsule were relayed to the Control Center by the relay airplanes and the Control Center was able to pass information to the Destroyer for retransmission to the astronaut. The entire landing and recovery operation was monitored on the air-to-ground net at the MCC. All indications were that the capsule systems had functioned properly during reentry and that the astronaut and capsule were in excellent condition.

The following are some of the major results of this test:

1. The astronaut's performance was excellent throughout the entire flight. His reports to the ground were easily understood and provided complete information on both his observations and the spacecraft systems performance. He was, as expected, able to perform systems management and it was through his management of these systems and, in particular, the capsule control systems, that it was possible to complete the 3-orbit mission. The astronaut was requested to perform several operations for which the ground did not have time to explain. His immediate response to these requests reflected his compliments to the ground control group which was gratifying and at the same time reflected his past training. One of the most significant results of the test was the astronaut's ability to use the horizon as a visual reference on both the daylight and dark side of the earth. He mentioned several times that he preferred and could do better using the window as his visual reference, as compared to the visual reference using the periscope. The visual reference also allowed him to be completely aware of the gyro reference system problems and the visual reference should be considered as one of the primary means in future tests.

2. The discovery of the telemetry signal indicating that the landing bag had deployed over CNV on the first pass created the most difficult decision to be made. As a result of this decision, it was decided to reenter without jettisoning the retropackage after retro-fire.

3. There were a number of malfunctions in the ASCS and FEW control systems. All of these discrepancies occurred in the operation of the low thrusters in the yaw axis. Because of the ability of the astronaut to overcome these discrepancies, the problems were considered to be minor.

4. There were a number of anomalies in the gyro reference system. From a real-time point of view, the horizon scanner reference system appeared to work satisfactorily while the capsule was on the daylight side of the earth, but was unable to provide a proper reference on the dark side. The reasons for this situation were unknown during the flight, but consideration should be given to an examination of the horizon scanner system in itself and any possible effects of the astronaut's use of the controls and gyro switch positions on the gyro reference system.

5. The oxygen usage rate on the primary system was as expected. However, an apparent leak developed after about 2-1/2 hours in the secondary oxygen supply system. The reasons for this leak were unknown.

6. The inverter cooling system failed to maintain either one of the inverters at the predicted temperatures and both inverters reached temperatures in excess of 200°. Although it had been planned to switch to the standby inverter when the temperature exceeded 200°, the rates of temperature rise were such that it was felt that there was no danger that the inverters would fail. Furthermore, tests performed in the last few months have indicated that the inverters will stabilize at temperatures on the order of 200° without cooling and last for periods of time much in excess of a 3-orbit mission.

7. The astronaut used rather large amounts of fuel from both tanks throughout the flight and at one time some concern was raised over the manual fuel usage. Even so, sufficient fuel remained at the time of retrofire on both systems to adequately control the capsule for the remainder of the flight.

8. The use of electrical power appeared to be nominal throughout the flight and at no time was there any problem associated with the power supply system of the capsule.

9. Other than the oxygen system problems discussed previously, the environmental control system performed completely satisfactorily.

10. The operational procedures used during the flight were entirely adequate, and it is felt that the procedures used during this flight will be satisfactory for MA-7.

11. The network performance was excellent throughout the entire mission in all aspects.

12. The use of the air-to-ground voice on the Goddard conference net simplified the entire operation and was one of the most useful tools in the entire network. In fact, the performance of this system far excelled what had been hoped for and made real time flight control possible.

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
February 27, 1962

MEMORANDUM for Chief, Flight Operations Division

Subject: Observations on Test 5460(MA-6)

Location: Goddard Space Flight Center

Position: Emil R. Schiesser and Joseph R. Thibodeau

Date: February 20, 1962

1. The Goddard personnel were cooperative and friendly.
2. Admittance to the computing room during operations was closely regulated.
3. All computing room personnel were called to special attention shortly before lift-off and both A and B computers and their associated plot boards appeared to function properly during launch.
4. During the orbit phase copies of the A and B computer on line printouts were analyzed by a small group near the C computer for possible numerical or procedural error in the real-time computing system. Included in this group was a representative from MSC.
5. The outputs from both computers were numerically identical up to a GMT of 17:45:00 or to Hawaii in the second orbit and indicated that good track data had been received from the remote sites.
6. The A computer stopped after the Hawaii station but was restarted at 17:51:00. The B computer remained operational throughout the entire flight but gave incorrect values for the number of observations received from the second pass Texas and Eglin stations at a GMT of about 17:58:00 due to a program error.
7. At the C computer, which used card input data from a teletype-card punch link, short arc solutions and other computations were successfully performed which served as an additional check on the A and B computers.
8. There was no debriefing after the shot. A debriefing on real-time computer operations within a day, and preferably the same day as the shot is recommended for a short rundown on individual observations and to serve as a focal point for the assimilation and distribution of readily available data.

9. The Goddard personnel cooperated in obtaining copies of the on-line computer printouts and other data for MSC analysis.

10. The following observations concern the Goddard observation and display room which was located next to the computing room and contained four real-time displays, one of which was a world map similar to that at the Mercury Control Center. The colorful fluorescent type map indicated which of the tracking stations was in contact with the capsule by means of a flashing light located at the geographical position of the station.

11. A second display consisted of a television picture projected on a large screen about four feet square, a technique which might be considered for any applicable MSC display requirements.

12. On a third display, teletype messages giving a rundown on the capsule systems and other important memoranda were projected.

13. A fourth display consisted of a permanent type running plot generated in bright yellow which could be compared with green nominal curves. From lift-off to insertion the flight-path angle was plotted against a velocity ratio using data tapped from a Goddard real-time data link. Following insertion this plot was replaced by a running ground track over a superimposed world map.

14. Communication between the Mercury Control Center, astronaut and radar stations was clearly audible.

15. Admittance to the observation room was restricted to authorized personnel.

Emil R. Schiesser
Aerospace Technologist

Joseph R. Thibodeau
Aerospace Technologist

ERS/JRT:am

JPM

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
March 2, 1962

MEMORANDUM for Flight Director

Subject: Report on Test 5460

Location: Mercury Control Center
Position: Flight Dynamics Officer
Date: February 20, 1962

1. The station was manned at 09:00Z, a live run with the IP 7090 checked out the system ahead of the normal schedule. Subsequent checks with the tape from the Burroughs buffer confirmed all high speed data systems looked good. A pad check with the Burroughs computer looked good, this was followed by a high speed data link test with the Burroughs computer. In the first data link test 1,000 transmissions were received by Goddard with no errors. A second data link test approximately two hours later gave the same results. During the second data link test, errors were intentionally induced to confirm that the correct results were being indicated. All high speed data lines looked good, in the southbound direction lines 1263, 1264, and 1265 were selected into the comparator for use during the mission. The worst line, (1262), showed some ringing but was useable, as was the primary backup line DTL-1. It would appear that further discussions with the OSFC on the quality of the data lines is necessary. AT and T clearly demonstrated that a high quality of data line is possible, since it was obtained for the mission, but the effort required to obtain this status always seems to call for action at a high level within NASA and AT and T. I believe that the same results should be obtained through normal routine checkout procedures.

2. At lift-off the selected source for display at the MCC was the output of the IP 7090. Cape FPS-16 tracking was utilized until approximately T+50 seconds when the IP 7090 switched to AZUSA. AZUSA was displayed for approximately the next 20 seconds, at which time GE/Burroughs via Goddard was selected and was displayed throughout the powered flight. The GE radar acquired both rate and track in the first cube at T+01:08, and never lost lock throughout the powered flight. The quality of the GE data was excellent up to SECO, and during the GO NO-GO computation.

3. The programed phase of the flight showed a minor deviation of +0.75 degrees in flight path angle, and +1.0 n.m. in altitude at BECO, which occurred at T+2:10. After staging, steering corrected this deviation in both altitude and flight path angle. A maximum deviation of +2.8 n.m. in cross range, and a residual of +50 fps in yaw velocity,

existed at cutoff. The yaw velocity looked very good up to approximately 35 seconds before cutoff, then appeared to lack response to steering with the final results as stated above. There appears to be conflicting evidence on this particular point since the impact point at the Canary Islands was right on the expected ground track, which is difficult to resolve with a residual velocity of 50 fps in yaw. Subsequent discussions with the Mission Analysis Branch indicates that the 50 fps observed at the MCC did not agree with the value displayed in the Burroughs computer room which was closer to 10 fps. This matter will be further investigated. The actual cutoff conditions were excellent, and are listed in table I.

4. Low speed tracking data from the remote sites were excellent, such that the orbit was well defined by the end of the first orbit. Subsequent tracking in the second and third orbits showed negligible changes in the orbit parameters. Apogee altitude of 141 n.m. was attained on the first orbit. The reduction in apogee altitude during the three orbits was approximately 1 n.m., the change in perigee altitude was negligible. The number of radar observations received from each site are shown in table II.

5. The "A" computer was lost during the second orbit between HAW and CAL. This matter will be further investigated since a similar situation occurred during the F-2 network checkout. At that time it was believed that a malfunction had occurred in one of the high speed input data channels. However, comprehensive checking failed to detect the actual cause of the malfunction, nor could it be reproduced. During the mission a restart was made in less than 5 minutes using the HAW vector, thus the computer was ready to accept the WIS data.

6. During the reentry tracking data pinpointed the landing location with a high degree of confidence. The final value after loss of track from the Cape FPS-16 differed by only 2 n.m. from that obtained on CAL data. The impact position obtained on the Goddard computers did not agree well with the values obtained from the Cape IP 7090, the Mils net report, or the pickup position as reported by the Recovery ship. This matter will be further investigated, but no explanation can be offered at this time. The values of the IP are as shown in table III. The large difference between the IP based on retrofire and that obtained from tracking cannot be explained at this time. A slight increase in the ΔV obtained from the retrorocket, or approximately +2 degrees in pitch attitude at retrofire could account for the reduction in reentry range.

7. The performance of the computing system and the tracking facilities was excellent throughout the mission, and until a more complete analysis has been made it is difficult to conceive any aspect that may be improved upon.

Tecwyn Roberts
Flight Dynamics Officer

Enc: Tables I, II and III

TR:cjh

Copies to: J. P. Mayer
J. J. Donnegan

TABLE I

QUANTITY	ACTUAL	NOMINAL
Velocity ratio with posigrades (Av. of GO NO-GO)	1.0002	1.00058
Inertial flight path angle (Av. of GO NO-GO)	-0.0674°	-0.0013°
Insertion altitude (Av. of GO NO-GO)	86.4 n.m.	86.98 n.m.
Inclination angle	32.54	32.5
Orbit capability	7*	—
Insertion velocity with posigrades	25,728 fps	25,736 fps
Apogee altitude	141 n.m.	144 n.m.

*Maximum number computed; actual orbit capability was approximately 100 orbits.

TABLE II

STN.	RADAR	TOTAL NO. OF OBSER- VATIONS	VALID OBSER- VATIONS	NON-VALID OBSER- VATIONS	NO. USED IN DIFF. CORR. IN COMPUTER	REMARKS
BDA	FPS-16	56	53	3	43	
	V	61	53	8	—	Verlort not used in d-c after correction on FPS-16
CYI	V	72	63	9	50	
MJC	V	93	76	17	50	
WOM	FPS-16	85	40	45	40	
GYM	V	64	51	13	44	
WHS	FPS-16	56	28	28	28	
TEX	V	71	46	25	0	Reason for no d-c not known at this time.
EGL	FPS-16	39	38	1	38	
	V	8	0	8	0	
CNV	FPS-16	71	43	28	35	
BDA	FPS-16	56	47	9	42	
	V	8	8	0	—	Verlort not used in d-c after corr. on FPS-16
CYI	V	54	46	9	34	
MJC	V	61	60	1	50	
WOM	FPS-16	65	29	36	29	
HAW	FPS-16	15	15	0	15	
	V	34	30	4	—	Verlort not used in d-c after corr. on FPS-16

TABLE II - Continued

STN.	RADAR	TOTAL NO. OF OBSER- VATIONS	VALID OBSER- VATIONS	NON-VALID OBSER- VATIONS	NO. USED IN DIFF. CORR. IN COMPUTER	REMARKS
CAL	FPS-16	29	28	1	28	
	V	18	5	13	—	Verlort not used in d-c after corr. on FPS-16
GYM	V	—	—	—	—	Passive track only.
WHS	FPS-16	63	31	32	31	
TEX	V	64	60	4	47	
EGL	FPS-16	42	41	1	38	
	V	17	9	8	—	Verlort not used in d-c after corr. on FPS-16
CNV	FPS-16	58	54	4	44	
BDA	FPS-16	60	58	2	49	
	V	2	1	1	—	Verlort not used in d-c after corr. on FPS-16
MUC	V	69	65	4	50	
HAW	FPS-16	38	38	0	38	
	V	23	14	9	—	Verlort not used in d-c after corr. on FPS-16
CAL	FPS-16	20	17	3	17	
	V	40	7	33	—	Verlort not used in d-c after corr. on FPS-16

TABLE II - Concluded

STN.	RADAR	TOTAL NO. OF OBSER- VATIONS	VALID OBSER- VATIONS	NON-VALID OBSER- VATIONS	NO. USED IN DIFF. CORR. IN COMPUTER	REMARKS
GYM	V	—	—	—	—	
WHS	FPS-16	61	34	27	34	
TEX	V	60	54	6	41	
EGL	FPS-16	23	22	1	18	
	V	24	13	11	—	Verlort not used in d-c after corr. on FPS-16
CNV	FPS-16	33	27	6	22	

TABLE III

Impact lat. and long. after conditions specified -

CONDITION	LAT.	LONG.
1. Retrofire time confirmed by CAL	21°08' N.	68°01' W.
2. D-C on CAL tracking	21°32' N.	68°55' W.
3. D-C on WHS tracking	21°29' N.	68°48' W.
4. D-C on TEX tracking	21°29' N.	68°48' W.
5. D-C on EGL tracking	21°31' N.	68°53' W.
6. D-C on CNV tracking	21°31' N.	68°53' W.

Cape IP 7090 impact data -

1. Based on Cape FPS-16 tracking	21°21' N.	68°31' N.
2. Based on San. Sal FPS-16 tracking	21°24' N.	68°35' N.
Value reported by Recovery	21°25' N.	68°37' N.

~~CONFIDENTIAL~~
109D FLIGHT EVALUATION



● LAUNCH TIME: 20 February 1962
9:47:39 EST (planned 7:30 EST)

● LAUNCH WEATHER: Temperature: 70.4°F
Humidity: 49.0%
Winds: 18 knots N with 25 knots gust
Cloud Cover: .2 alto-cumulus @ 16,000 ft.

● LAUNCH HOLDS: Rate Beacon: 45 minutes @ T-120
Capsule: 10 minutes @ T-120
Capsule Hatch: 40 minutes @ T-60
Fuel Topping: 15 minutes @ T-45
Lox Transfer: 25 minutes @ T-22
Tracking Computer: 2 minutes @ T-6:30
TOTAL 137 minutes (90 minutes built-in hold not included)

Classification changed to U
By authority of EO 11652
Date 6/1/72

Date 4/25/74

● All booster mission objectives were successfully accomplished.

● No flight anomalies were observed.

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DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

WORD ONE/KEYSEARCH

D:04-02-62 NS N:00 R MER

Flight Evaluation and NS R0112A
Analysis MA-6
Mercury Atlas 6

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~~CONFIDENTIAL~~

109D Flight Analysis

	<u>PREDICTED TRAJ.</u>	<u>ACTUAL FLIGHT</u>	<u>POST SIMULATION</u>
Lox Weight, @ L. O., lb.	168,629	168,394	168,182
Fuel Weight, @ L. O., lb.	74,544	74,179	74,263
Dry Weight, Sustainer & Adapter, lb.	5,805	5,805	5,805
Capsule, lb.	2,982	2,993	2,993
Phase II Pressure, psig.	3.75	3.55	3.55
Phase III Pressure, psig.	25.5	25.8	25.8
Gox, lb.	400	---	285
BECO, Time, Sec. (Transmitted)	132.59	129.83	129.83
Altitude, ft.	206,813	207,780	206,000
Inertial Velocity, fps.	10,517	10,270	10,256
SECO, Time, Sec. (Transmitted)	297.50	301.47	301.47
Altitude, ft.	528,179	527,690	528,200
Inertial Velocity, fps.	25,696	25,707	25,705
Total Propellants, lb.	659	714	693
Outage, lb.	259	207	193
Burnable propellants	400	507	500
Engine, Booster, Isp, Sec.	251.3	---	252.0
Sustainer, Isp., Sec.	215.0	---	216.3
Influence Coefficients	.0432	---	.1200
Pitch Factor	1.0	---	.99

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ORBITAL INSERTION PERFORMANCE

	<u>Planned</u>	<u>88D</u>	<u>93D</u>	<u>109D</u>	<u>Tolerance Requirements</u>
Inertial Velocity, fps.	25,695 (25,715)	25,680	25,685	(25,707)	+ 25
Altitude, Ft.	528,500	526,710	526,990	527,690	+ 2000
N.M.	87.0	86.7	86.7	86.9	+ .33
Flight Path Angle, Deg.	0	-.14	-.10	-.08	+ .20
Cross Range Velocity, fps.	-6	-20	-31	-10	+ 30
Orbit Characteristics					
Perigee, N.M.	87.0	85.9	86.5	86.9	
Apogee, N.M.	134.0 (149.0)	123.3	128.0	(140.9)	

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PERFORMANCE MARGINS

	88D		93D		109D		
	Predicted	Actuals	Predicted	Actuals	Predicted (Redline)	Predicted (Flight)	Actuals
Total Propellants @ SECO	801	844	738	918	659	774	714
Outage	229	187	195	241	259	209	207
Burnable Propellants	572	657	543	677	400	565	507
GOX	320	---	243	---	400	285	---
Impulse Time Available, Sec.	2.1	2.5	2.0	2.5	1.5	2.1	1.8
30° Dispersion, Sec.	.6 to 3.6		.5 to 3.5		0 to 3.0	.6 to 3.6	

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WEIGHT SAVING AREA

<u>ITEM</u>	<u>CHANGE</u>	<u>ESTIMATED WEIGHT SAVINGS (LBS)</u>
1. GUIDANCE	MOD III A TO MOD III G	77
2. AZUSA	B TYPE TO C TYPE	18
3. MAIN MISSILE BATTERY	EAGLE PITCHER TO YARDNEY	10
4. P. U. SYSTEM	D SERIES TO E SERIES ELECTRONICS WITH D SERIES MANOMETERS	27
5. P. U. RECALIBRATION	BIAS THE P. U. SYSTEM TO DECREASE THE OUTAGE	60
6. RANGE SAFETY	REPLACE WITH LIGHTWEIGHT UNIT	16
7. INVERTER	REPLACE BENDIX WITH LELAND	9
8. BAFFLE INJECTOR	INSTALL BAFFLE INJECTOR IN THE BOOSTER ENGINE	120
9. BECO TIME	COMMAND STAGING AT LOWER ALTITUDE	130
10. DERATE VERNIERS	REDUCE VERNIER THRUST BY A FACTOR OF 2	71
11. LOX START TANK PROBE	CHANGE TO LONGER FILL PROBES	23
12. BOOSTER ENGINE THRUST	UPRATING THRUST	STUDY
13. ALTITUDE START OF VERNIER ENGINES	START VERNIER AT BECO	STUDY

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NASA - Manned Spacecraft Center
Langley Station
Hampton, Virginia
April 11, 1962

MEMORANDUM for Chief, Flight Operations Division

Subject: Reported recovery of pieces of MA-6 sustainer at 30.75 degrees South latitude and 26.75 East longitude

1. Reports indicate that a part of the MA-6 sustainer was sighted at about 1:00 GMT on February 21, 1962 and was recovered at 30.75 degrees South latitude and 26.75 degrees East longitude.
2. This would indicate that the MA-6 sustainer reentered during the sixth orbit; however, our calculations using tumbling drag and the composite model atmosphere (NASA Working Paper 205) indicate that the sustainer should not have reentered until the tenth orbit. For reentry to occur in the sixth orbit the density of the composite model atmosphere or the Atlas drag coefficient or a combination of the two would have to be increased about 92.5 per cent. This appears to be quite large as the Womersley vector on the third orbit was integrated backwards to insertion using this density increase with capsule drag and the position is off by about 6 miles. If the sustainer flew at a 90 degree angle of attack the drag coefficient at orbital altitude would be increased by about 38 per cent. This situation is not likely to happen thus the percentage error in drag coefficient would be much less than 38 per cent (closer to the tumbling drag).
3. The velocity change of the sustainer due to the pop-gun effect of postgrade firing has been calculated to be a maximum of 4.8 ft/sec. For reentry to occur in the sixth orbit using the composite model atmosphere and tumbling drag the sustainer ΔV due to postgrade firing would have to be approximately 45 ft/sec.
4. The accuracy of the initial conditions and possible error in the Atlas weight was also investigated to determine the effect on the sustainer lifetime. The measurements of velocity, flight-path angle and altitude are accurate to within .5 ft/sec, .005 degrees and 157 ft. respectively. The above accuracy was determined by backward integration from all tracking stations using MA-6 data to insertion and comparing the differences. The Atlas weight has little effect on the lifetime as a reduction of 600 pounds makes less than one orbit change. (reentry in the 10th orbit).

5. A ship located at $28^{\circ} 20'$ North latitude and $77^{\circ} 04'$ West longitude reported sighting what was thought to be the Atlas at 01:37 GMT time on the 21st at a bearing of 216 degrees and an elevation of 39 degrees. At this time the Atlas would be in the 6th or 7th orbit and the elevation for the above location would be well below zero making observation impossible. It is therefore not considered likely that this ship saw the MA-6 sustainer.

6. Trinidad made their last observation at 21:07 GMT on the 20th but did not define the orbit. Space Track made observations in the 4th orbit and defined the 5th orbit as having an apogee of 104 statute miles and a perigee of 98 statute miles with a period of 87.4 minutes. Our calculations using the composite atmosphere show that the 5th orbit apogee should be 131.6 st. miles and the perigee should be 95.5 st. miles with a period of 87.9 minutes. When increasing the composite atmosphere by 92 per cent the apogee, perigee and period change to 108.8 st. miles, 88 st. miles and 87.4 minutes respectively. When using the composite atmosphere and integrating an orbit such as Space Track has defined at the beginning of the 5th orbit the Atlas will go an additional 5 orbits before reentry.

7. There is a possibility that the sustainer may have come apart in orbit. The effect of heating on the sustainer possibly could have caused the tank to rupture or the destruct package to blow up. This could account for the fragments reentering earlier than would be expected. Space Track personnel have indicated that one of the Sputnik boosters did come apart in orbit and that the engines orbited longer than the tankage.

Charlie C. Allen
Aerospace Technologist

CCA:am

JHM

4-16/7
NASA - Manned Spacecraft Center
Port Canaveral, Florida
10 April 1962

MEMORANDUM for Chief, Flight Operations Division

Subject: MA-6 T/M R and Z Calibrations

Reference: ISI No. 24 for Test 5460

1. During the MA-6 flight six T/M calibration commands were sent from MUC, and four were sent from CNV (Table I). This memorandum attempts to summarize the results of the R and Z/cal checks and point out some problems which arose during MA-6. Since T/M-Lo was used as the primary link by all sites, only the T/M-Lo R and Z/cals are considered here.

2. Inspection of the T/M R and Z/cal results as reported during the MA-6 operation shows only small changes in the Z/cals at both MCC and MUC and a maximum R/cal shift of +4PFS (250 VA inverter temperature) at MCC. However, the MUC R/cals for suit inlet temperature, 250 VA inverter temperature, and 150 VA inverter temperature (segments 11, 21, and 32 respectively) are considerably higher than the F-1 day values. The R and Z/cals for the above parameters are summarized in Table II and the differences as reported by MUC are shown in Table III.

The MUC reports gave R/cal values for segments 11, 21, and 32 which were greater than the F-1 calibrations by +9, +7, and +5 PFS respectively (Table II). The apparent discrepancy between the R/cal differences given in Tables II and III is due to a small difference between the calibration points on the meter scales and the F-1 day calibrations. Based on the above results it appears that there was a problem in the R/cal readout on segments 11, 21, and 32 of MUC.

3. In an attempt to identify the nature of the problem a review was made of the MUC T/M Confidence Test reports, the Mission Summary Messages and the Visicord records. Thus far the problem is not pinned down. However, examination of the visicord records for all R and Z/cals (Table IV) does not confirm the MUC reports of large R/cal changes in segments 11, 21, and 32 and indicates that the problem exists between the T/M receiver station and the meters on the Flight Control Consoles.

As a further check it is suggested that the MA-6 T/M tapes be returned to MUC to be played back through their equipment to assist in tracking down the source of the difficulty.

Send Copy to John Nudge
Gus Kwang
J. M. Preston *

Cps sent 4-19-62

[Handwritten signature]

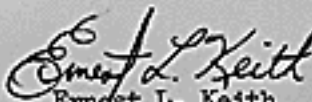
MEMO for Chief, Flight Operations Division

10 April 1962

4. Since the MCC and MUC R/cal's differed and because of the lack of T/M calibration data from other command sites it was not possible to establish which site was reporting the correct results during the MA-6 operation. Therefore MCC was not able to provide the network with any correction to the T/M calibrations. A recommendation regarding revised R and Z/cal procedures is the subject of a separate memorandum.

Another factor which contributed to the confusion was the failure of MUC to report R and Z/cal changes in absolute percentage readings from the meter face. Rather they reported changes in percent of full scale deflection (i.e. + 10). Instructions in reference (a) were intended to establish that the calibration change reports be in absolute percentage readings from the meter face. However, after reviewing reference (a), it must be recognized that it is poorly written and the reporting instructions could easily be misinterpreted. These procedures must be clarified before MA-7.

5. Another problem in the T/M calibration area of a different but similar nature was the fact that MSC - POD issued a new calibration for the 250 VA inverter temperature subsequent to the flight. This curve was based on data which was available before the flight. In this instance the change had a favorable affect on the temperature (Fig. 1) averaging about a 6 degree reduction. However, the opposite could have been true and could lead to dangerous circumstances if the calibration change were large. Every effort must be extended to assure that the most up-to-date calibrations are available to the network before each operation.


Ernest L. Keith
Aerospace Technologist

ELK:bas

RDH 

Copy to: HCKyle

A. M. Preston, POD 4-19-62
JDH/EFK, 4-19-62

INSTRUMENTATION SUPPORT INSTRUCTION 24 FOR TEST 5460

Addition to FCH -2

1. For Test 5460 the following sites will command and monitor "R/CAL" and "Z/CAL":
 - 1st Orbit MUC and CNV
 - 2nd Orbit MUC and CNV
 - 3rd Orbit MUC

If a calibration change is noted by one of the above sites, the next command site as directed by MCC should prepare to also send these commands.

2. The commands are to be made after the flight controllers have taken their first readings of the telemetry data. "Z/CAL" is to be commanded first followed by "R/CAL". These commands are to be completed in time to allow additional "Z/CAL" or "R/CAL" commands for unlocking the relay if it does not release properly.
3. Each command is to be sent for 5 sec. before any readings are taken. After 8 sec. it is essential that a wave train be made for verifying any changes noted on the meters.
4. In general only changes of plus or minus 3 percent are to be reported in real time. This report should be in percent of full scale. If a parameter has a plus or minus 3 percent change in one of the CALS, both calibration points in PFS are to be reported. The values reported are to be read from the wave train.
5. Calibration reports should be included in post message, or if necessary a spe msg. MCC will review the calibration and, if necessary, issue a correction to update the TLM calibrations.

INSTRUMENTATION SUPPORT INSTRUCTION NO. 58 FOR TEST 5460.

1. Correction to ISI 24 on telemetry calibrations paragraph 4 last sentence shud read: "The values reported are to be read from the display meter."
2. Pam Wavetrain recorded by the Visicorder is too small in deflection for accurate readouts. More accurate data can be obtained from the meters.
3. MCC is excluded from this correction.

TABLE I

MA-6 TELEMETRY R AND Z CALIBRATE FUNCTION TIMES

STATION	CALIBRATE FUNCTION	CAPSULE ELAPSE TIME *	DURATION OF COMMAND *
Michea	Z/CAL	00:51:47.5	21 sec.
	R/CAL	00:52:14	32 sec.
Canaveral	Z/CAL	01:36:12	10 sec.
	R/CAL	01:36:24	14 sec.
Michea	Z/CAL	02:27:21	15 sec.
	R/CAL	02:27:55	36 sec.
Canaveral	Z/CAL	03:09:58	9 sec.
	R/CAL	03:10:09	11 sec.
Michea	Z/CAL	04:00:08	17 sec.
	R/CAL	04:00:32.5	23 sec.

* Values Obtained from On-Board Recording

TABLE II

Summary of Reported MA-6 T/M R and Z Calibrations --
Percent of Full Scale (PFS)
Low Link

Seg. No.	Parameter	Calibrate Function	F-1 Day CAL'S	Final CAL'S (Note 1)	MUC 1st Pass (Note 2)	MUC 2nd Pass (Note 2)	MUC 3rd Pass (Note 2)	MCC 1st Pass (Note 3)	MCC 2nd Pass (Note 3)
11	Suit inlet temperature	Z/CAL R/CAL	18.9 85.0	18.0 85.0	17 94	17 94	17 94	19 88	18 87
21	250 VA inverter temperature	Z/CAL R/CAL	18.0 85.3	17.6 87.5	18 91	18 93	18 93	19 89	18 89
32	150 VA inverter temperature	Z/CAL R/CAL	19.7 86.0	19.0 88.0	19 91	19 90	19 90	19 89	19 89

- Notes: 1. Final CAL'S were based on pre-flight data but were not available until after the flight.
2. Muchea reported changes in PFS. These were added to meter scale values of R and Z/CAL points to obtain the PFS absolute (see Table III).
3. MERCURY Control Center data was read from Visicord Records..

TABLE III

Summary of Differences in MA-6 T/M Calibrations
as reported by Muchea -- Percent Full Scale (PFS)
Low Link

Seg. No.	Parameter	Calibrate Function	Meter Scale	Reported Change	MUC 1st Pass	Reported Change	MUC 2nd Pass	Reported Change	MUC 3rd Pass
11	Suit inlet temperature	Z/CAL R/CAL	17 84	0 +10	17 94	0 +10	17 94	0 +10	17 94
21	250 VA inverter temperature	Z/CAL R/CAL	19 85	0 + 6	19 91	0 + 8	19 93	0 + 8	19 93
32	150 VA inverter temperature	Z/CAL R/CAL	18 86	0 + 5	18 91	0 + 6	18 92	0 +6	18 92

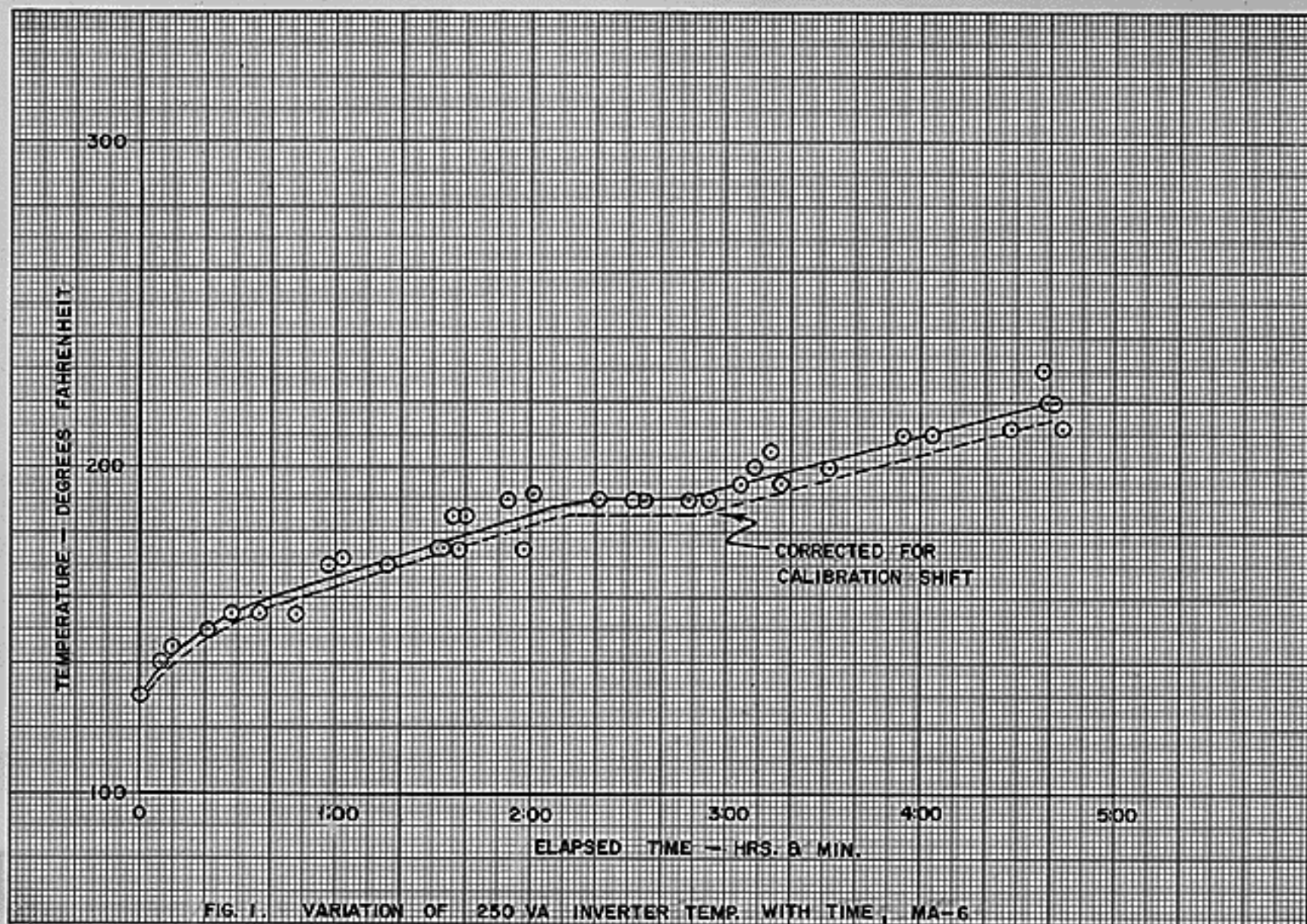
- Note: 1. Since readings of reported change were made from the meter scales, it is assumed that the change was in reference to the meter scale markings of Z and R/CAL.

TABLE II
SUMMARY OF MA-6 T/M CALIBRATION DATA AS OBTAINED FROM VISICORDER RECORDS
PERCENT OF FULL SCALE
LOW LINK.

TLM	Parameter		F-1 Day Calibrations	Final Calibrations	MCC T-2 Min.	MCC 1st Pass	MCC 2nd Pass	MCC Average	MUC 1st Pass	MUC 2nd Pass	MUC 3rd Pass	MUC Average	On-Board Average	MCC Avg. Minus On-Board Average	MUC Avg. Minus On-Board Average
			Note 1	Note 2									Note 3		
OH-12 SEG.															
	Z/CAL	CURVE													
4	Body Temperature	B	6.8	6.5	6.8	6.7	6.7	6.7	6.4	6.7	6.8	6.6	5.7	+ 1.0	+ 0.9
6	Oxygen Partial Pressure	B	0.3	0.0	0.5	0.6	0.9	0.7	0.0	0.0	0.0	0.0	0.1	+ 0.6	- 0.1
10	Cabin Air Temperature	A	16.5	16.0	16.1	16.8	16.2	16.4	16.4	16.1	16.0	16.2	15.0	+ 1.4	+ 1.2
11	Suit Inlet Air Temperature	A	18.9	18.0	18.1	19.0	18.3	18.5	17.7	17.9	17.9	17.8	17.2	+ 1.3	+ 0.6
19	Fuel Line Temp-Manual Roll	C	40.0	40.0	40.3	41.7	41.5	41.2	40.4	41.2	41.4	41.0	39.9	+ 1.3	+ 1.1
20	Fuel Line Temp-Auto Low Roll	C	31.2	31.0	32.1	32.7	31.9	32.2	31.4	31.8	31.1	31.4	30.8	+ 1.4	+ 0.6
21	250 VA Main Inverter Temp	A	18.0	18.0	18.1	18.8	18.2	18.4	17.7	17.8	18.2	17.9	16.8	+ 1.6	+ 1.1
32	150 VA Inverter Temp	A	19.7	19.0	18.8	19.6	18.9	19.1	18.6	19.1	18.7	18.8	17.9	+ 1.2	+ 0.9
42	D.C. Current Monitor	A	1.1	0.0	0.4	0.8	1.1	0.7	0.0	0.1	0.0	0.0	- 0.1	+ 0.7	+ 0.1
64	Calibrate Signal (Event)		(27)	24.0	25.6	24.5	24.9	25.0	25.1	25.3	25.5	25.3	25.2	- 0.2	+ 0.1
76	Heat Shield Temperature	B	5.6	5.5	5.1	5.4	5.1	5.2	4.6	5.1	4.8	4.8	4.9	+ 0.3	- 0.1
80	Retro Rocket Temp	B	8.6	9.0	8.7	9.9	10.2	9.6	9.4	9.8	10.0	9.7	9.4	+ 0.2	+ 0.3
81	TLM Trans. Temperature	B	17.4	18.5	16.9	17.8	17.8	17.5	17.1	17.5	17.4	17.3	17.1	+ 0.4	+ 0.2
86	Horizon Scanner Monitor-Roll	A	52.5	52.0	52.0	52.2	52.2	52.1	51.9	52.2	51.8	52.0	51.4	+ 0.7	+ 0.6
88	Horizon Scanner Monitor-Pitch	A	60.5	59.0	60.4	60.9	60.4	60.6	60.9	60.5	60.5	60.6	60.2	+ 0.4	+ 0.4
	R/CAL													Z/CAL DIFF.	+ 0.82 + 0.53
4	Body Temperature	B	78.3	78.5	78.4	78.8	78.8	78.7	78.0	78.7	79.1	78.6	77.9	+ 0.8	+ 0.7
6	Oxygen Partial Pressure	B	79.3	78.5	78.0	78.3	78.0	78.1	78.1	77.4	77.8	77.8	77.4	+ 0.7	+ 0.4
10	Cabin Air Temperature	A	60.1	60.0	59.9	60.5	59.9	60.1	60.7	60.5	60.7	60.6	59.3	+ 0.8	+ 1.3
11	Suit Inlet Air Temperature	B	85.0	86.0	87.3	87.8	87.4	87.5	87.6	87.7	88.3	87.9	86.8	+ 0.7	+ 1.1
19	Fuel Line Temp-Manual Roll	C	98.0	98.5	99.5	99.7	100.0	99.7	99.7	99.7	100.1	99.8	99.0	+ 0.7	+ 0.8
20	Fuel Line Temp-Auto Low Roll	C	92.1	92.5	91.9	90.2	90.2	90.8	91.9	92.0	92.2	92.0	91.0	- 0.2	+ 1.0
21	250 VA Main Inverter Temp.	A	85.3	88.0	88.9	88.9	88.9	88.9	88.2	88.5	88.9	88.5	87.4	+ 1.5	+ 1.1
32	150 VA Inverter Temp.	A	86.0	88.0	88.8	88.6	89.1	88.8	88.7	88.7	89.0	88.8	88.0	+ 0.8	+ 0.8
42	D.C. Current Monitor	A	86.7	86.0	86.1	86.3	86.1	86.2	86.3	86.4	86.3	86.3	85.5	+ 0.7	+ 0.8
64	Calibrate Signal (Event)		(76)	75.0	74.8	76.3	75.9	75.7	75.1	75.4	75.8	75.6	75.6	+ 0.1	0.0
76	Heat Shield Temperature	B	66.3	65.0	66.5	67.0	67.4	67.0	66.0	67.3	67.6	67.0	67.0	0.0	0.0
80	Retro Rocket Temperature	B	83.9	84.0	84.5	85.7	86.0	85.4	85.5	86.3	86.7	86.2	85.8	- 0.4	+ 0.4
81	TM Trans. Temperature	B	84.7	85.0	85.7	86.5	86.8	86.3	86.2	86.9	87.2	86.8	86.4	- 0.1	+ 0.4
86	No R/CAL														
88	No R/CAL													R/CAL DIFF.	+ 0.41 + 0.68

NOTES: 1. This calibration data was provided to the network.
2. Final R & Z/CAL'S were based on pre-flight data.
3. Values are averages of 6 sets of readings presented in "Post Launch Memorandum Report for MA-6, Part II", dtd: March 5, 1962 (Pg. 17-19).

Z/CAL AVG. + 0.67
R/CAL AVG. + 0.54
TOTAL DIFF. + 0.61



NASA - Manned Spacecraft Center
Langley Station
Hampton, Virginia
April 9, 1962

MEMORANDUM for Chief, Flight Operations Division

Subject: Determination of the errors which caused the MA-6 capsule landing point to be 39 nautical miles from the planned impact point

1. The planned impact point for the MA-6 primary recovery area H was $21^{\circ} 07'N$ and $68^{\circ} 00'W$ based on a nominal retrofire time of 04:32:58. The insertion conditions for the MA-6 mission were not exactly nominal, and this caused a slightly different than nominal orbit. This new orbit required that the retrofire time be changed to 04:33:08 in order to land at the planned impact position. However, the actual landing point *was* $21^{\circ} 25'N$ and $68^{\circ} 41'W$ as reported by the recovery ship twenty minutes after capsule landing and $21^{\circ} 26'N$ and $68^{\circ} 41'W$ as determined from the trajectory integration.

2. A study was made to determine the possible causes as to why the actual impact point was 39 nautical miles short of the planned landing point. It was discovered that the weight loss of hydrogen peroxide, due to the manual control of the capsule for two orbits, was much greater than the planned weight loss. The actual hydrogen peroxide used from insertion to retrofire was 42 pounds. The nominal weight loss of hydrogen peroxide for three orbits is 16 pounds. Using the corrected weight of the capsule a new impact point of $21^{\circ} 21'N$ and $68^{\circ} 30'W$ resulted from the trajectory integration. This newly computed impact, as a result of the corrected capsule weight, landed 31 nautical miles short of the planned impact point. This new impact point accounts for 31 of the 39 nautical miles that the actual impact was short of the planned impact point.

3. It was also decided to investigate the error in the impact point caused by the attitude (pitch and yaw) errors during retrofire. Using the actual attitudes during retrofire as obtained from the onboard capsule tape and the corrected capsule weight, an impact position of $21^{\circ} 22'N$ and $68^{\circ} 34'W$ resulted from the trajectory integration. The attitude errors during retrofire, thereby, caused the impact point to fall an additional 4 nautical miles short, resulting in a total accountable error of 35 nautical miles.

4. Capsule System personnel furnished the retrothrust performance information which was slightly greater than the nominal thrust of the retrograde rockets used on MA-6. This additional retrothrust caused the capsule to land an additional 2 miles short.

Subject: Determination of the errors which caused the
MA-6 capsule landing point to be 39 nautical
miles from the planned impact point

April 9, 1962

5. The combined errors of capsule weight, attitudes during retrofire and retro performance resulted in a total error of 37 nautical miles, which is 95 per cent of the total impact error. The remaining error can possibly be attributed to wind in the recovery area and drift of the capsule while in the water. It can be seen that an indication of the weight loss while in orbit due to the hydrogen peroxide used, will help to land the capsule closer to the primary landing point.

Donald J. Incerto
Aerospace Technologist

DJI:dsc

JPM

Copies to: J. D. Hodge
T. Roberts
R. F. Thompson
C. R. Huss
C. R. Hicks, Jr.
D. Beckman
H. C. Kyle
G. S. Lumley
M. S. Carpenter, Lt.
L. G. Cooper, Capt.
J. H. Glenn, Lt. Col.
W. M. Schirra, Lt. Comdr.
D. E. Slayton, Major
A. B. Shepard, Jr., Comdr.
V. I. Grissom, Capt

W. C. Williams
Messing Proj. Off } 7-16-62

NASA - Manned Spacecraft Center
Langley Station, Hampton, Va.
March 29, 1962

MEMORANDUM for Distribution List

Subject: MA-6 Flight Test Reports

Copies of MA-6 Flight Test Reports received up to the present time are attached. There are a number of reports outstanding and as soon as they are received they will be forwarded.

for: Chris C. Kraft
Christopher C. Kraft, Jr.
Flight Director

Enc:
1 copy each report

EKS:s

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✓ ~~Dr. J. L. Huettner, Marshall~~

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Distributed 3-29-62-EKS

Langley Air Force Base, Virginia

From: Manned Spacecraft Center

To: Marshall

Attn.: Dr. J. P. Kuttner

Subject: MA-6 Flight Test Reports

Reference:

1. The following marked items should be noted.

- ☐ The enclosed material requires Headquarters action (by _____).
- ☐ The enclosed material is for your information and files.
- ☐ The enclosed material is forwarded in response to reference.
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- ☐ Attention is called to paragraph(s) _____ of enclosure.
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- ☐ For reply by your office.
- ☐ Forward information in enclosure to:

2. The following correspondence is being forwarded for your information and files:

- a. Flight Director's report for Test 5460 (MA-6) February 20, 1962
- b. Flight Surgeon's report for Test 5460 (MA-6) February 20, 1962
- c. Procedures' report for Test 5460 (MA-6) February 20, 1962
- d. Memorandum dated February 27, 1962 re observations on Test 5460 (MA-6), by Emil R. Schiesser and Joseph R. Thibodeau
- e. Flight Dynamics Officer's report for Test 5460 (MA-6) February 20, 1962
- f. Retrofire Controller's report for Test 5460 (MA-6) February 20, 1962
- g. Capsule Environment Monitor's report for Test 5460 (MA-6) February 20, 1962.

CCK:eks

Walter G. Williams
Associate Director

Enc: 1 copy each report a through g

MSC Form 115 (Nov 1961)

Copy to: NASA Headquarters, Attn.: Mr. G. H. Low, MS (with 1 copy ea encls)

C. Kraft
file

FOR OFFICIAL USE ONLY

* NETWORK STATUS MONITOR/
REPORT TO FLIGHT/DIRECTOR/

MERCURY/ATLAS (MA-6)

TEST DATE 20 February 1962



FOR OFFICIAL USE ONLY

D:00-00-00 NPO W:00 R MER*NETWORK... MA-6 ABBITT R0212A

FOREWORD

This report is prepared for the MERCURY Flight Director and Network Commander by the Network Status Monitor, MERCURY Support Planning Office and the Technical Assistance Group, PAA Program Management.

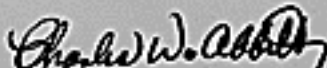
Part I is a brief summary of the over-all operation as observed by the Network Status Monitor.

Part II is an instrumentation summary and Part III provides coverage charts of the MERCURY Global Network support as prepared by the Technical Assistance Group.

Part IV provides the Post Launch Instrumentation Messages (PLIMS) as received from the Global sites.

This report is a preliminary composite of the Global Network support for the MA-6 operation. It is published for distribution within 24 hours of test termination. In addition to being used by the MERCURY Flight Director and the Network Commander, it is distributed to key members of the MERCURY operating team for post-flight evaluation purposes.

APPROVED:



Charles W. Abbitt, Colonel, USAF
NETWORK COMMANDER

CONTENTS

- I NSM SUMMARY
- II INSTRUMENTATION SUMMARIES
 - A. Radar
 - B. Telemetry
 - C. Command Control
 - D. Communications
- III COVERAGE CHARTS
- IV POST LAUNCH INSTRUMENTATION SUMMARY
MESSAGES (By Station)
 - A. Preliminary Estimate of Coverage
(See Part III)
 - B. Instrumentation Problems
 - C. Monitoring
 - D. General

NETWORK STATUS MONITOR SUMMARY

Test 5460

20 February 1962

I. COUNTDOWN

A. NETWORK

The Network countdown was started at T-6:00 (0600Z). The 30 minute built-in hold at T-2:00 was extended for an additional 55 minutes due to GE rate beacon and Astro microphone troubles. Additional holds were called for a faulty hatch cover bolt, booster fuel topping, and a GSE problem at the pad. At T-0:12 (1433Z) power was lost to the BDA computer. Although power was restored within 4 minutes, a 5 minute hold was necessary at T-0:07 to verify that the computer was operational. Count was resumed at 1441Z and continued without break to lift-off marked at 14:47:39Z.

During the count CAL reported a Verlort modulator transformer failure, the 01 teletype circuit affecting the IOS and WOM was out for 10 minutes, and periodic fading of the ATS primary teletype circuit was experienced. These problems caused no holds and at lift-off all network instrumentation was green.

For the T-60 camera coverage estimate, none of the long focal length camera sites reported above 10 percent coverage. The weather improved in the Canaveral area and at last estimate prior to lift-off all sites were estimating 100 percent coverage at all altitudes.

B. CADFISS

The CADFISS short roll call was conducted on time at T-4:00. Bermuda failed Test 41 (Verlort boresight) and the problem was attributed to high winds at the site. CAL failed Test 81 (Verlort range target) as a result of the transformer failure having occurred during the CADFISS test. The CNV FPS-16 was relieved from Tests 42 and 44 (boresight) to improve a poor signal-to-voice ratio that had been identified earlier. The radar had passed the GSC/CNV (only) CADFISS test run earlier in the count.

A data flow test was run during the built-in hold at T-2:00 with BDA Test 41 closed limits. Although this test normally involves Tests 41 and 42, CAL Test 81 was added to check the Verlort. All sites passed

except CAL 41 and 81 (Verlort still red) and CYI Test 41. The CYI failure was caused by propagation and involved only the back-up circuit through the ATS.

The last data flow test was run at T-0:55. All sites were programmed for open limits and all test results were satisfactory.

MISSION

All phases of network participation were excellent and complete tracking coverage was provided throughout the mission. With exception of the minor problems noted below the network remained green.

a. Radar - during the first orbit Texas Verlort data was not used at Goddard. Although 32 valid data points were received these were not used by the on-line computer. BDA reported that CNV rabbit identifier was not working on first pass causing delay in C-band acquisition by BDA.

b. Communications - the CYI primary TTY circuit was lost momentarily early in the mission and the voice link went out late in the third orbit. Both were quickly restored prior to adversely affecting the mission.

c. Telemetry - no problems noted.

d. Command - Command handover was carried out as had been planned for the mission. Times were nominal and no problems were noted.

e. RF Interference - there were 17 interference reports received from MERCURY Control Center during the operation. These interference reports are broken down as follows: HF Frequency 6; Telemetry Frequency 7; Radar 4.

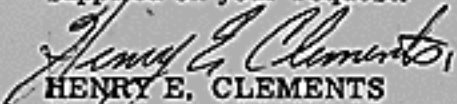
HF Interference - one report was received after recovery. Another, which was traced to foreign shipping and could not be acted upon, soon disappeared. All others either closed down or faded out.

Telemetry Interference - one was identified as a SAC aircraft and shut off through ADC Control at Jacksonville. One was caused by Radar in PMR area and was shut off. Three reports were unidentifiable and two were received as interference reports caused by storms in the area.

Radar Interference - Eglin AFB noted S-band radars at MacDill and Tyndall and requested they adjust to other frequencies. PMR reported C-band interference from a Harmonic of an S-band radar in the area and closed it down. HAW reported radar interference that was not identified. This radar was believed to be shipborne and aircraft were dispatched to close it down. CNV reported C-band radar interference on lift-off that has not been identified.

COMMENTS

1. From a network standpoint, the mission was an unqualified success. Radar coverage and communications remained excellent throughout; better than previous missions and simulations.
2. Voice circuits to the ships, through AMR single sideband, worked well.
3. The telemetry aircraft recorded signal from 7 minutes prior to impact through impact.
4. The IOS did not release balloon flares because of high winds. Parachute flares were released during first two orbits but were not observed by Astronaut, probably due to low intensity and cloud cover. The high winds and overcast precluded release of any flares on the third orbit.
5. The many Command maintenance problems identified during the past month indicate a possible design deficiency in the system.
6. The computer systems at CNV, GSC and BDA were each lost during the mission and simulation periods because of power fluctuations.
7. Problems in implementing the MA-6 Information Plan were encountered. Tracking Station Statements Nrs. 1, 4 and 5 were released. However, Tracking Station Statements #2 (Network Acquisition Statement) were not released by NASA as planned. Only one release (for Bermuda) was received at network sites. Since arrangements had been made at several sites to release information on local activities during the mission, the lack of approval from MERCURY Control Center on individual passes caused confusion and, in some cases, resentment by local press representatives.
8. Additional details on network operation during this mission will be supplied on your request.


HENRY E. CLEMENTS
Captain USAF
Network Status Monitor

NETWORK STATUS MONITOR COUNTDOWN LOG

Test 5460

GMT	T-TIME	EVENTS
0600	T-6:00	AND COUNTING
0630	T-5:30	AND COUNTING
0700	T-5:00	AND COUNTING
0730	T-4:30	AND COUNTING
0757	T-4:03	EGL reported interference cleared.
0800	T-4:00	AND COUNTING - Start CADFISS
0819	T-3:41	CAL reports Verlor red due to trigger transformer.
0835	T-3:25	CADFISS Complete.
0900	T-3:00	AND COUNTING
1000	T-2:00	HOLDING. 30 MIN BUILT-IN HOLD
1000	T-2:00	Start CADFISS Roll Call.
1015	T-2:00	CAL Verlor Green.
1016	T-2:00	CADFISS Data Flow Test Complete.
1030	T-2:00	HOLD Extended, replacing GE Rate Beacon.
1110	T-2:00	HOLD Extended, working on Astro helmet microphone.
1115		GSC 01 RCV CKT Out (Cable) IOS, Woomera
1125	T-2:00	GSC 01 CKT Green.
1225	T-1:00	COUNTING
1305	T-1:00	HOLDING. Replacing bolt on capsule hatch cover.
1320	T- :45	COUNTING
1335	T- :45	HOLDING, To top off fuel.
1358	T- :22	COUNTING
1423	T- :22	HOLDING. GSE problem at the Pad.
1433	T- :12	COUNTING
	T- :08	BDA Computer has lost power.
1438:30	T- :06:30	Power restored at BDA Computer.
1441	T- :06:30	HOLDING for BDA Computer checkout.
1447:40	T-0	COUNTING
1452:45		LAUNCH
		Capsule in orbit. More than seven orbit capability. Nominal trajectory. Apogee 138 nm.

II INSTRUMENTATION SUMMARIES

A. RADAR

The MERCURY Radar Tracking System performed extremely well. All stations obtained track on all passes where the capsule was above the horizon. Both C and S-band beacons were in excellent condition throughout the entire flight. Some minor phasing problems were evident; however, no serious data losses occurred as a result.

The Goddard Computers were supplied with more than enough data on each orbit to keep the trajectory updated.

The communications circuits used for radar handover held up throughout the entire pre-count and subsequent orbits. Circuit discipline on this circuit was very good.

II INSTRUMENTATION SUMMARIES

B. TELEMETRY

Preflight - Bermuda requested permission to interchange tracks 11 and 14 on their tape recorder because of a wow and flutter problems. This permission was granted immediately.

A report was received from the blockhouse that their decom had failed. The necessary readouts were supplied by MCC.

MUC reported failure of tracks 1 and 2 on their tape recorder. They were advised to interchange the data on these tracks with the data on tracks 3 and 11, if tracks 1 and 2 were not fixed prior to T-0. No further report was received.

Flight - Telemetry performance during the flight was very good with few failures being reported. BDA had interference on the high link, however, the data was not degraded. The HF P/P transmitter caused interference with the TLM signal for the first 3 minutes of acquisition time, while the contact message was being transmitted.

Muchea lost Pen 4 of the Systems Monitor recorder during the second pass. This reading was duplicated on the systems panel so no loss occurred. The ATS had trouble with the Aero-Med Sanborn recorder. No other failures were reported.

II INSTRUMENTATION SUMMARIES

C. COMMAND CONTROL

Cape Canaveral, GBI and San Salvador's Command Control equipment performed satisfactorily. During launch these AMR stations were used for Range Safety purposes. ASCO was recorded as being transmitted from San Salvador at 14:52:40.475 GMT or 301.475 seconds after lift-off. R-CAL and Z-CAL functions were transmitted from Cape Canaveral on the first and second orbits.

R-CAL and Z-CAL functions were transmitted from Muchea on the first, second and third orbits.

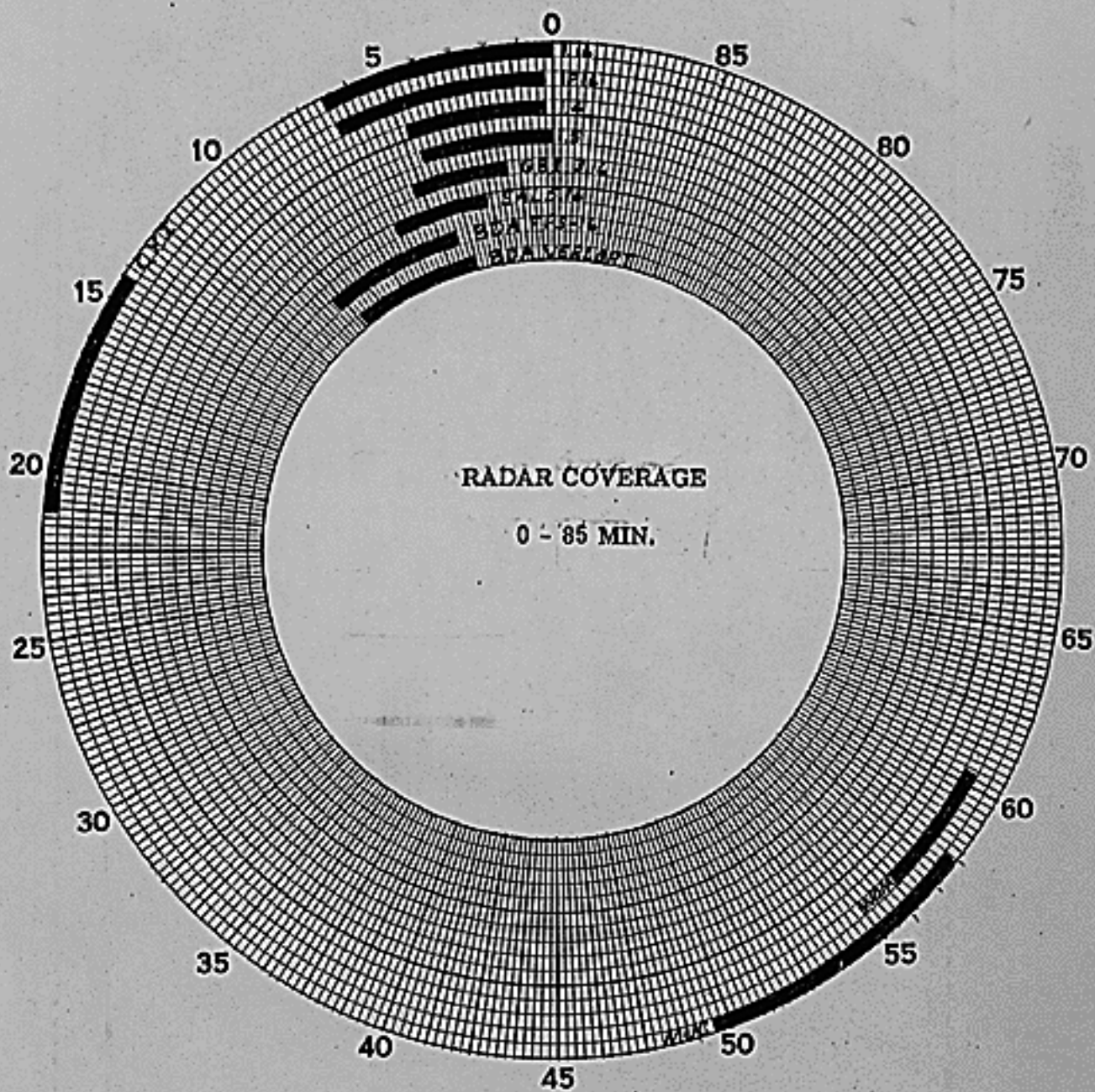
Command Control systems performed as expected at all command sites.

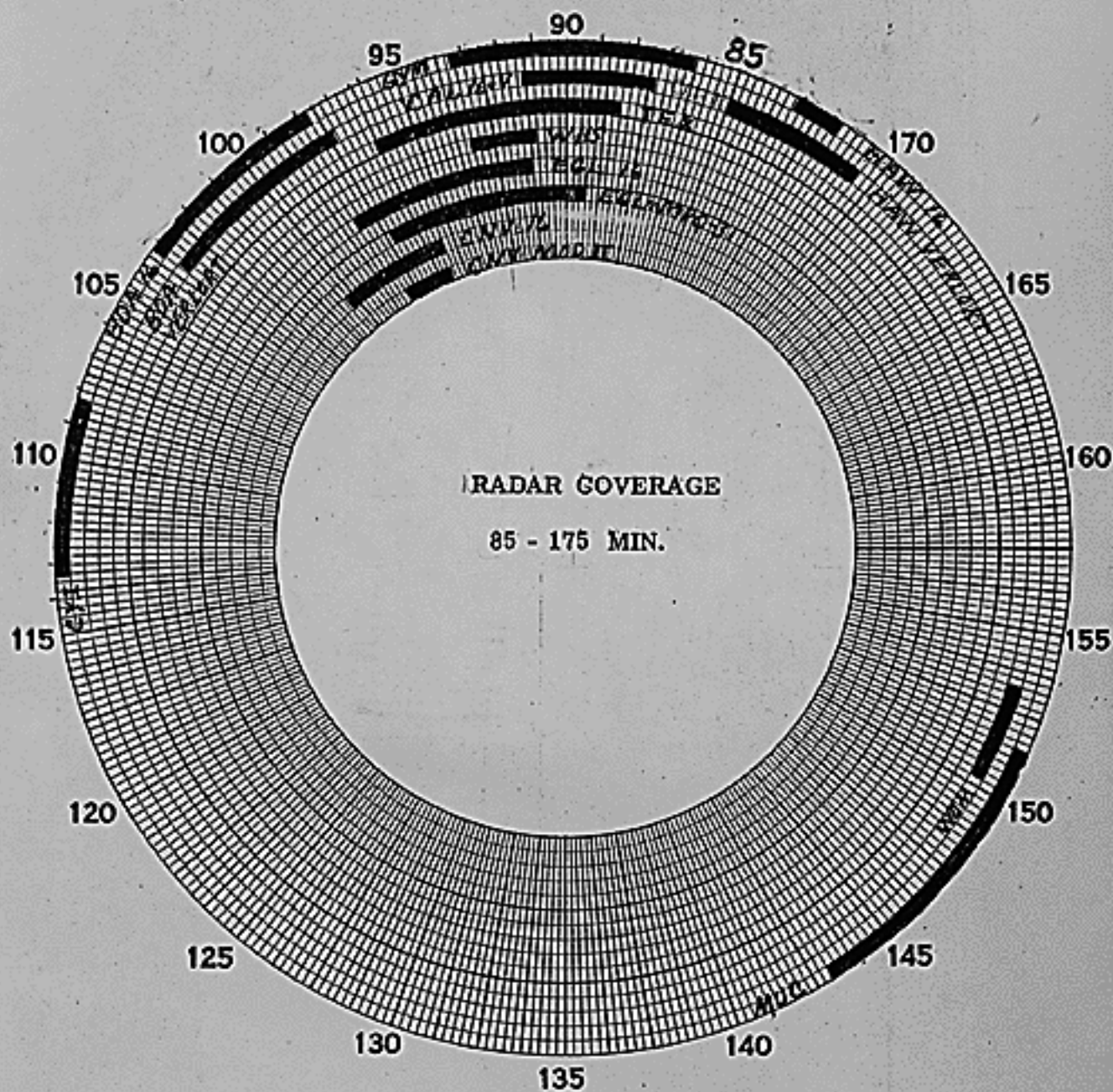
On board Command Control signal strength recordings will be evaluated as soon as the data becomes available. Command Control carrier ON-OFF times and best function times will then be reviewed and changes made, if required.

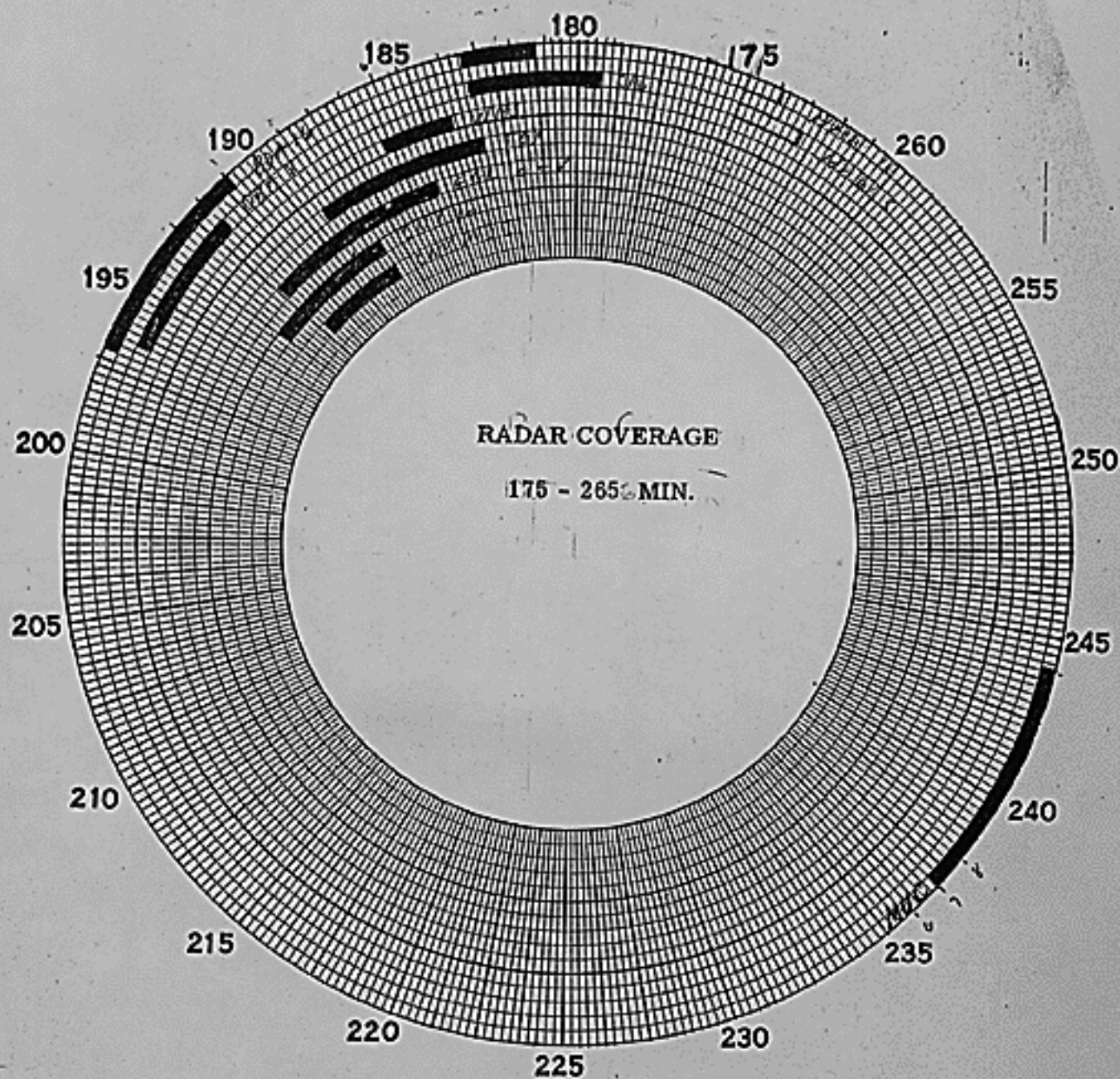
II INSTRUMENTATION SUMMARIES

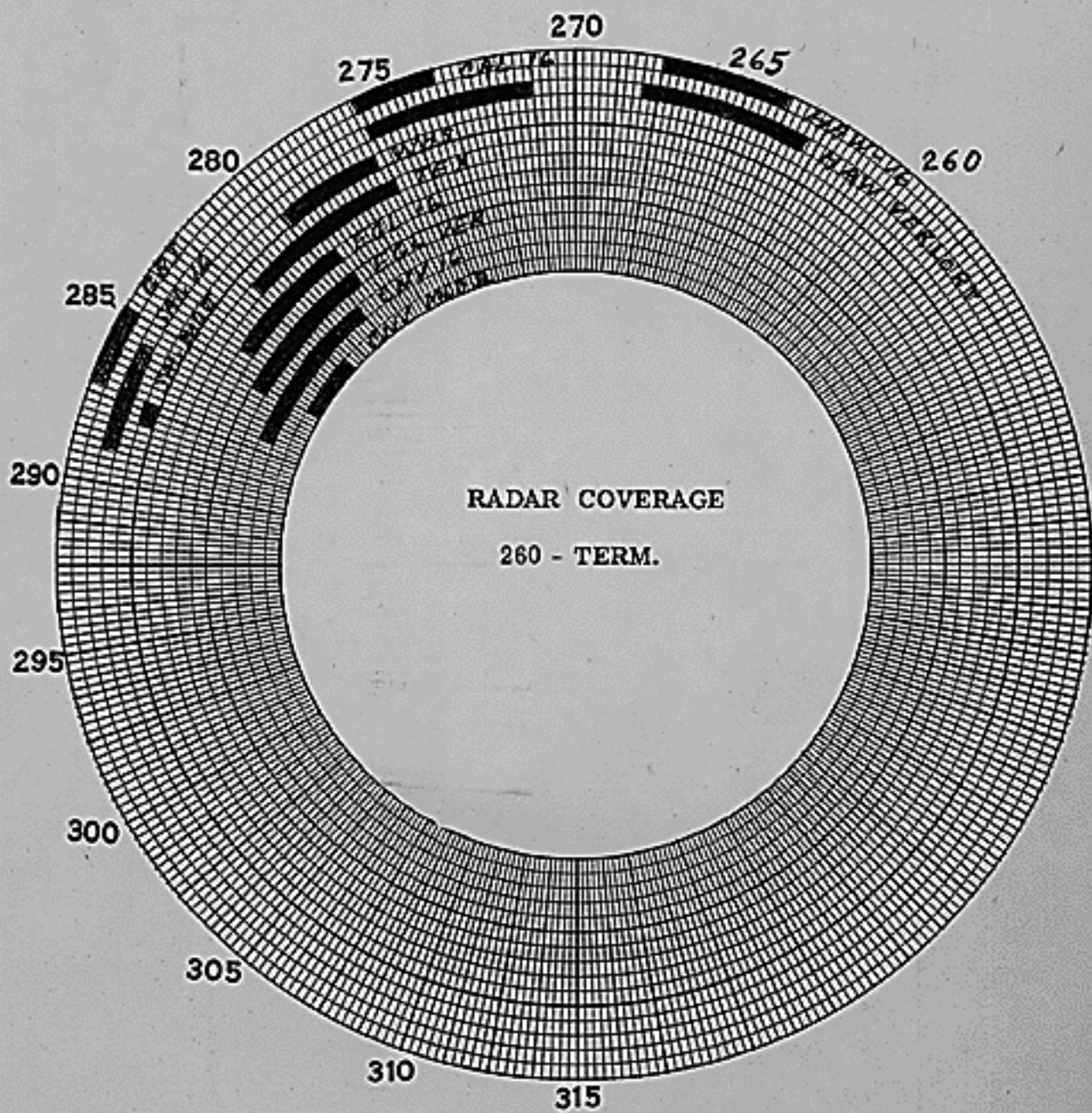
D. COMMUNICATIONS

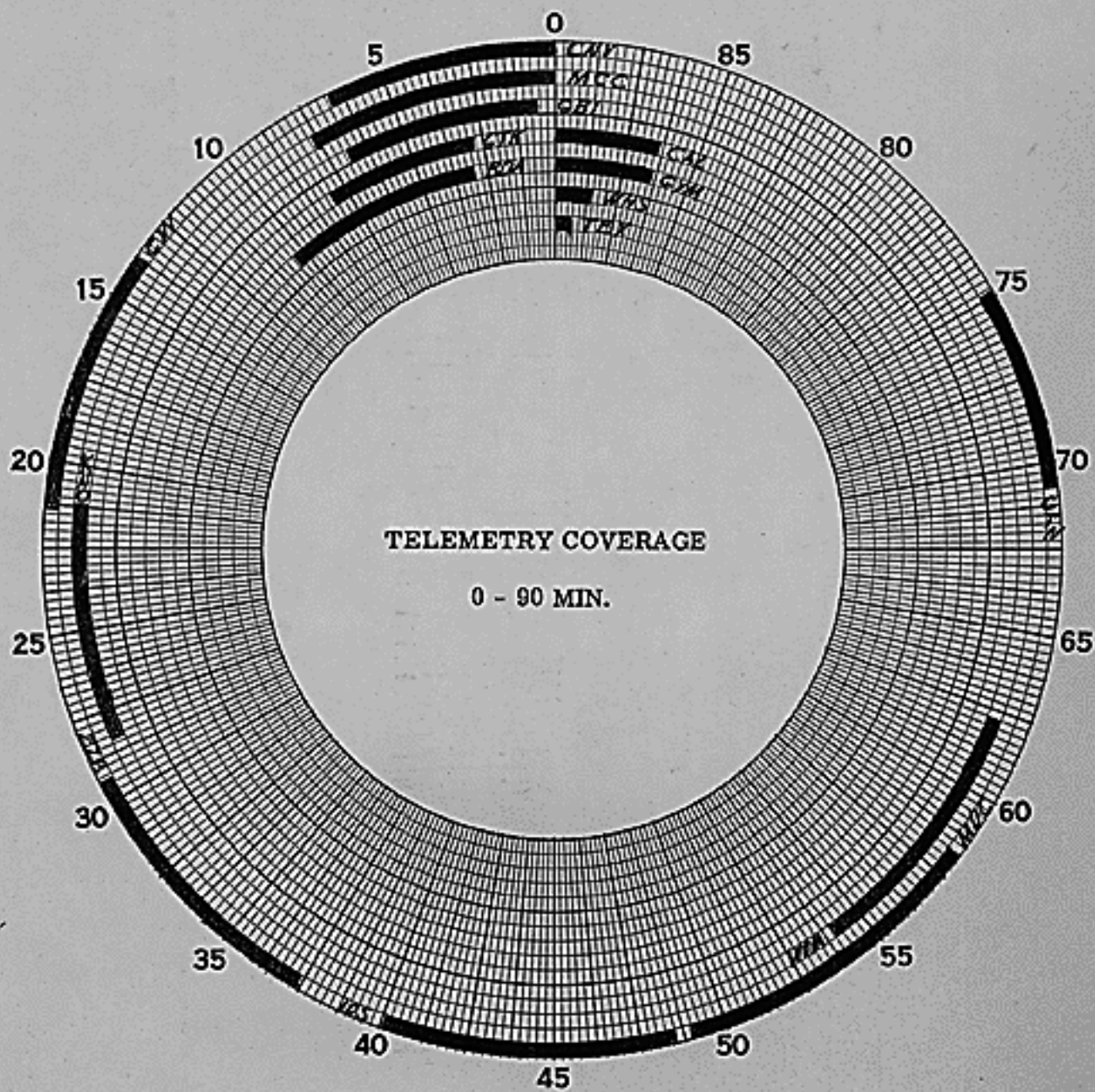
There were no obvious air-ground communications problems between ground stations and capsule. Coverage was exceptionally good throughout the mission until the terminal phase when the capsule was approaching Grand Bahama and Grand Turk. This is to be expected due to "blackout effects". However, fair-to-good reception was maintained after "drogue chute" deployment and was maintained until the capsule was onboard the recovery vessel.

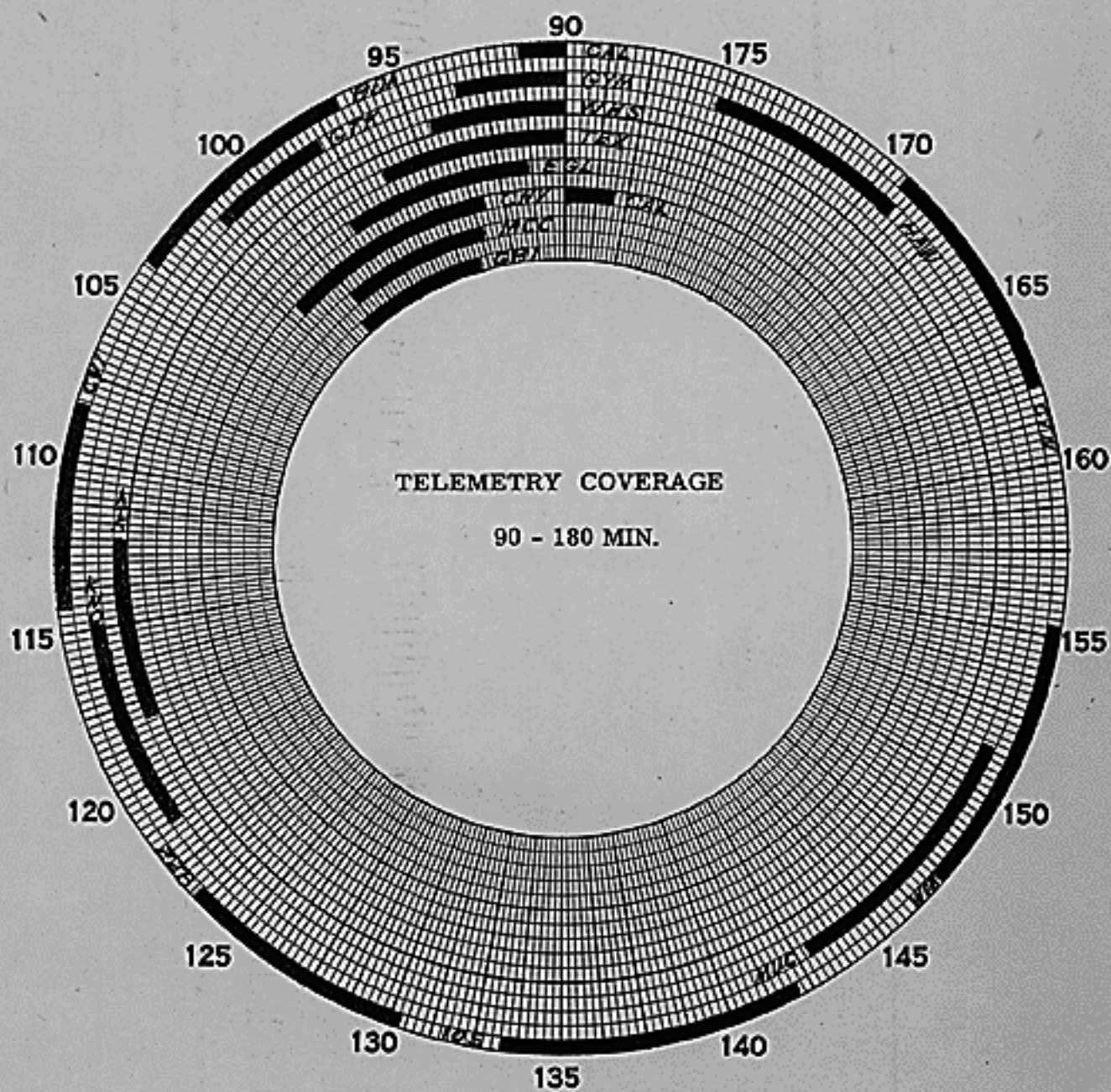


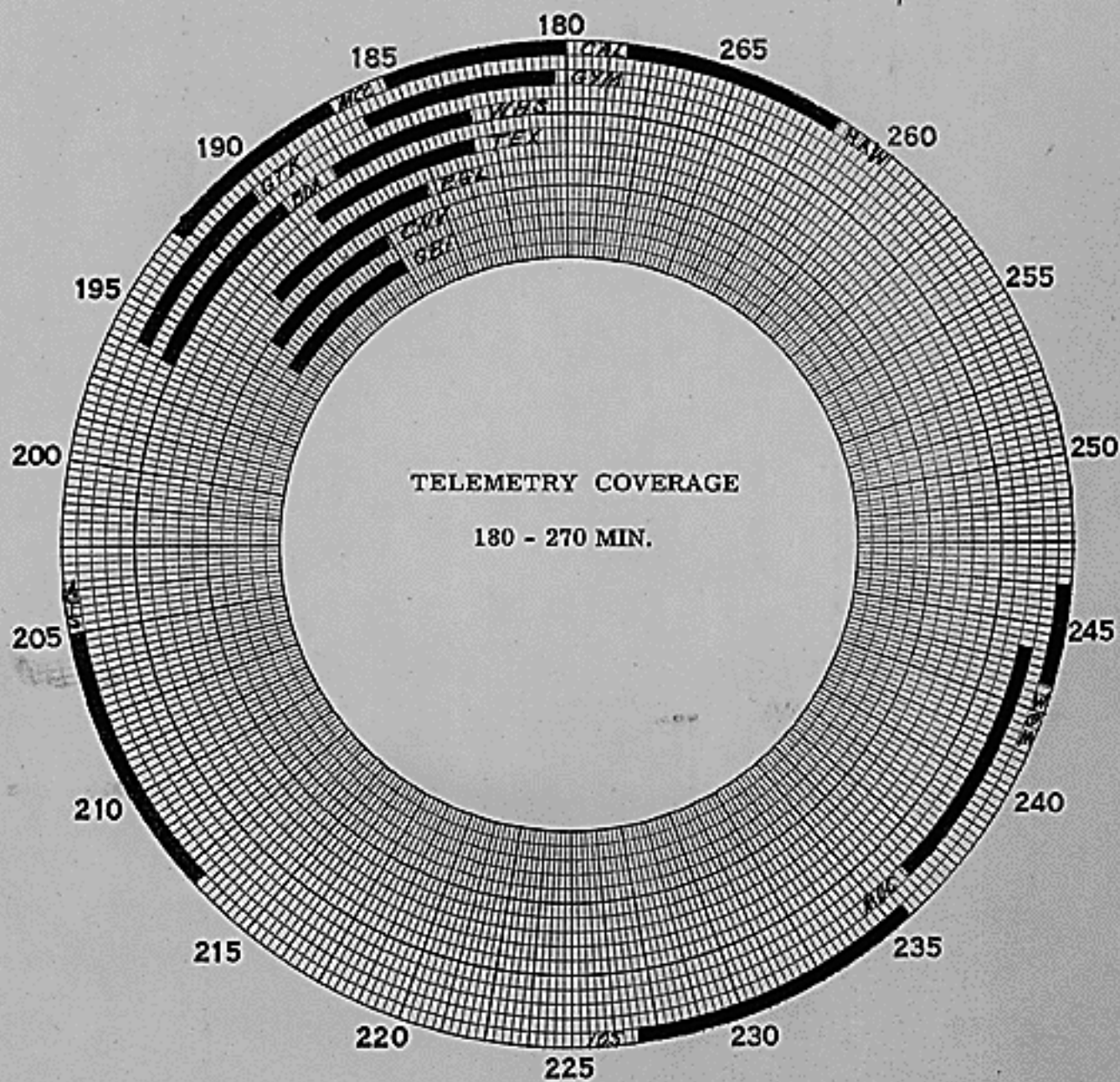


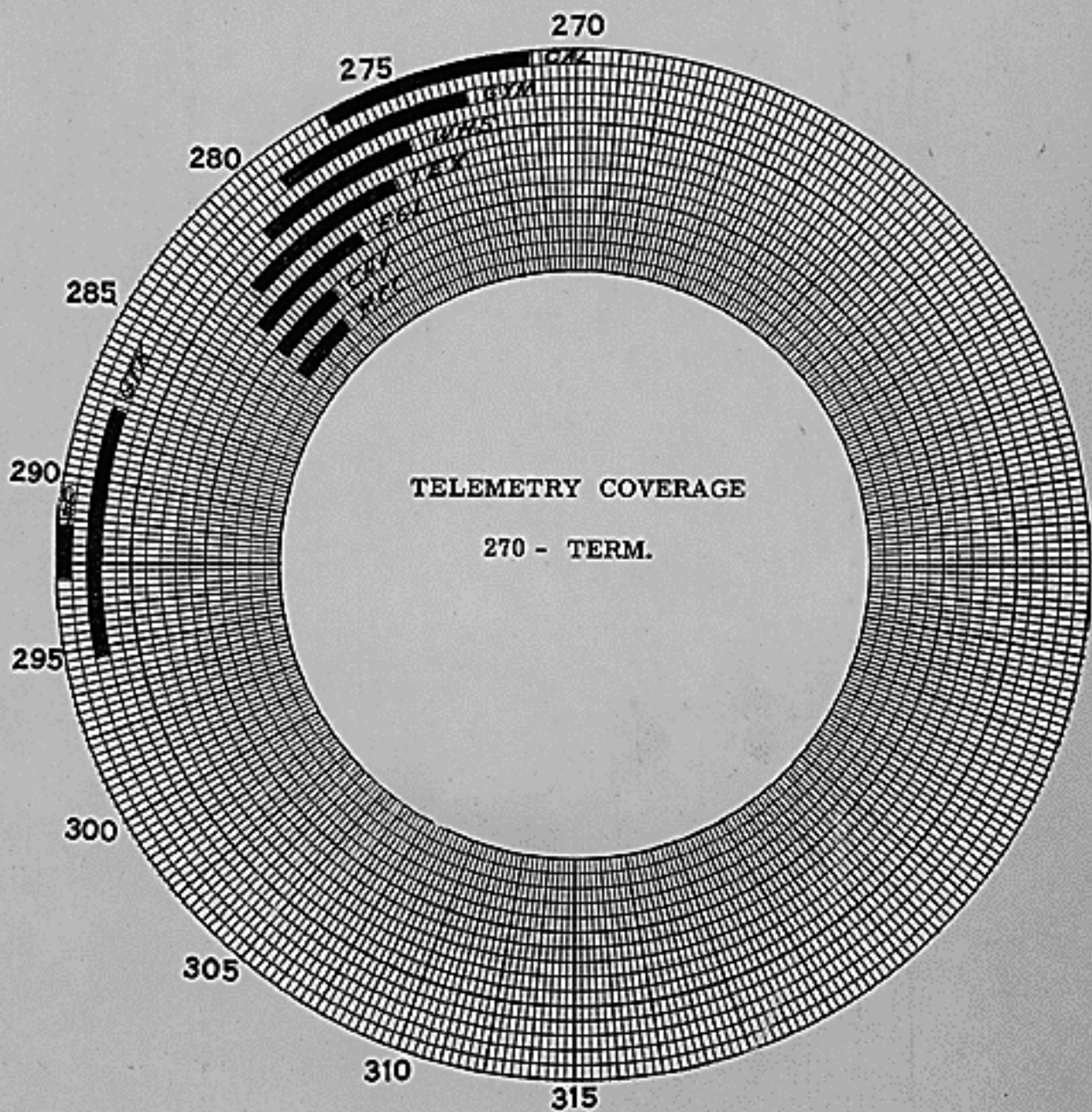


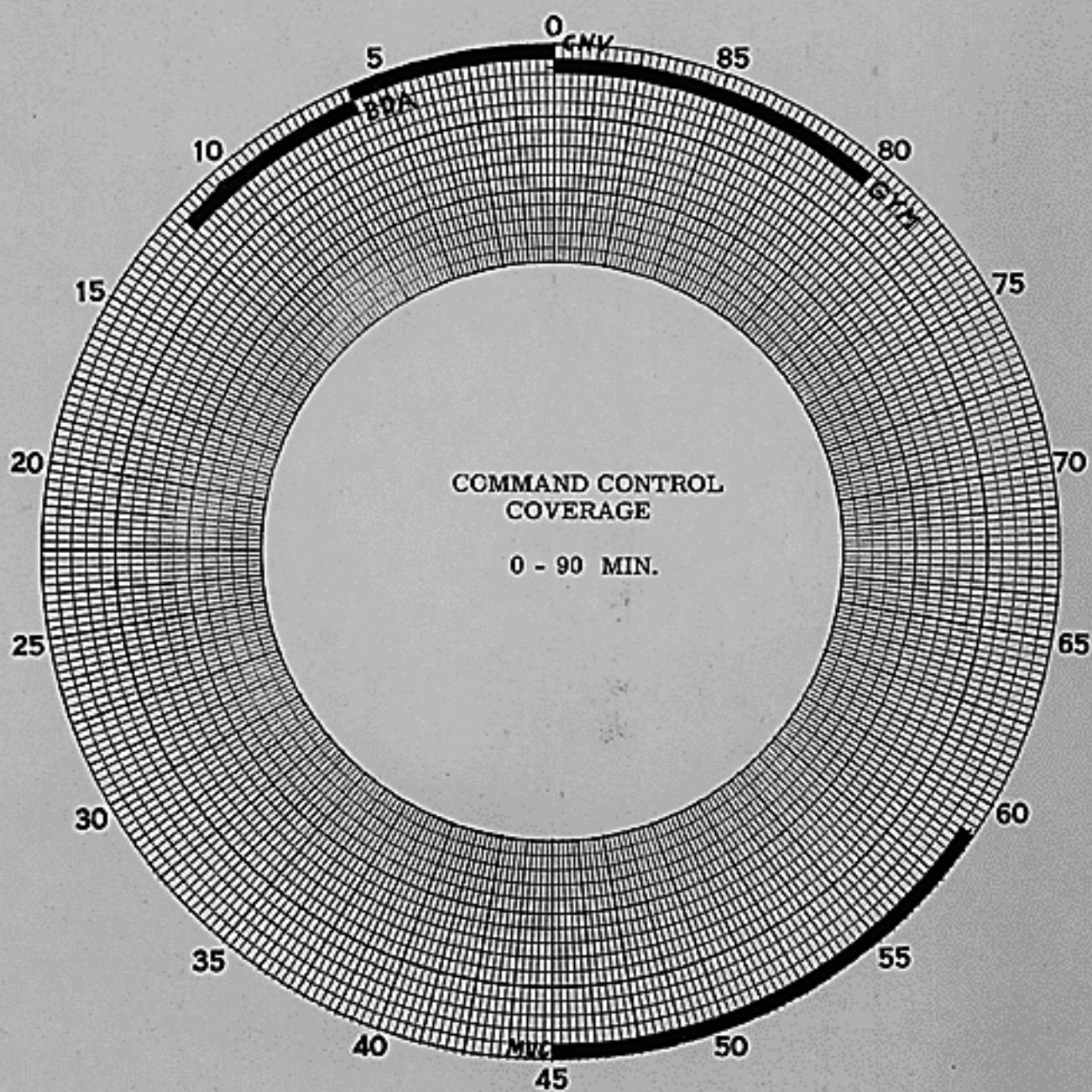


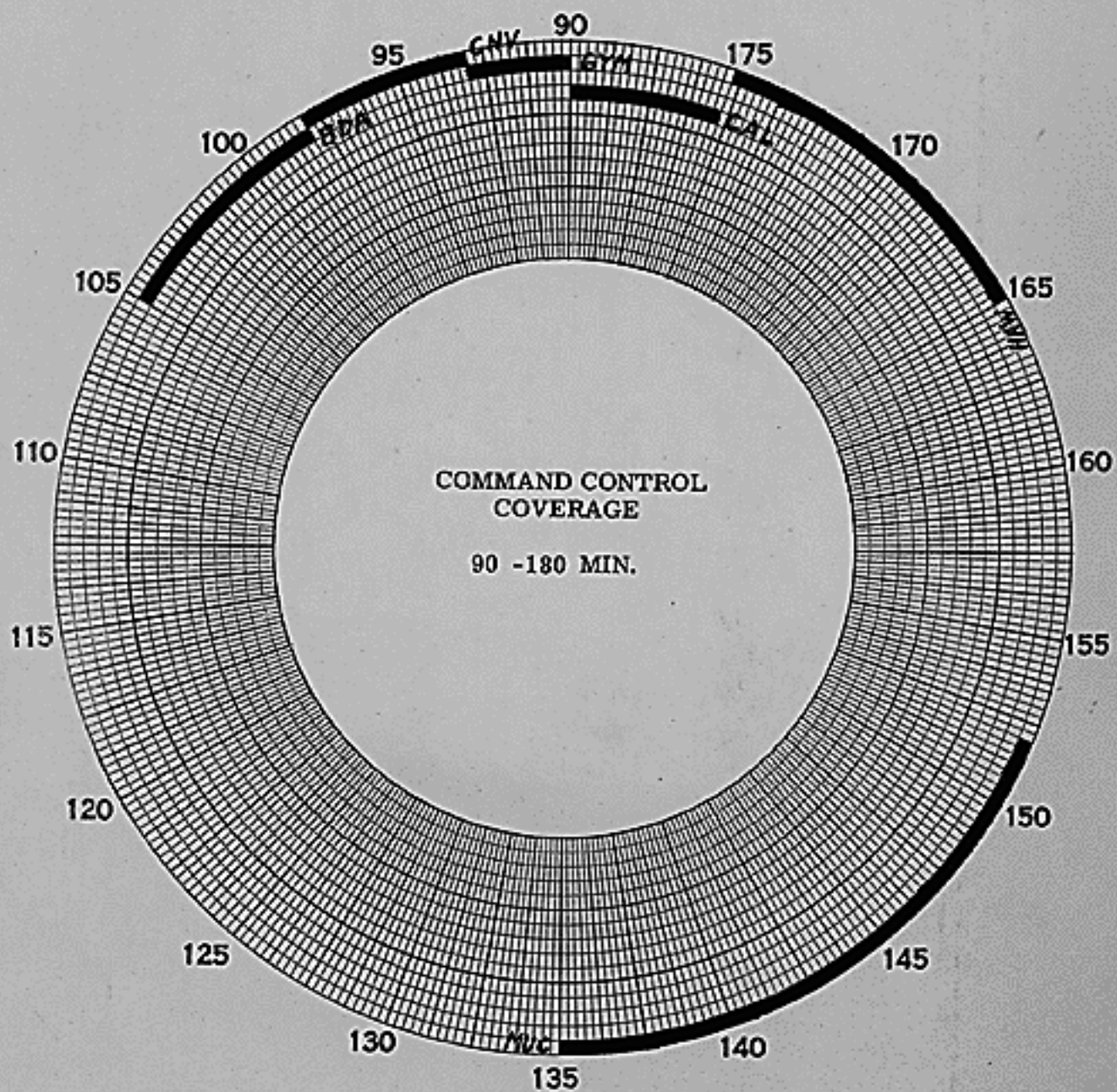


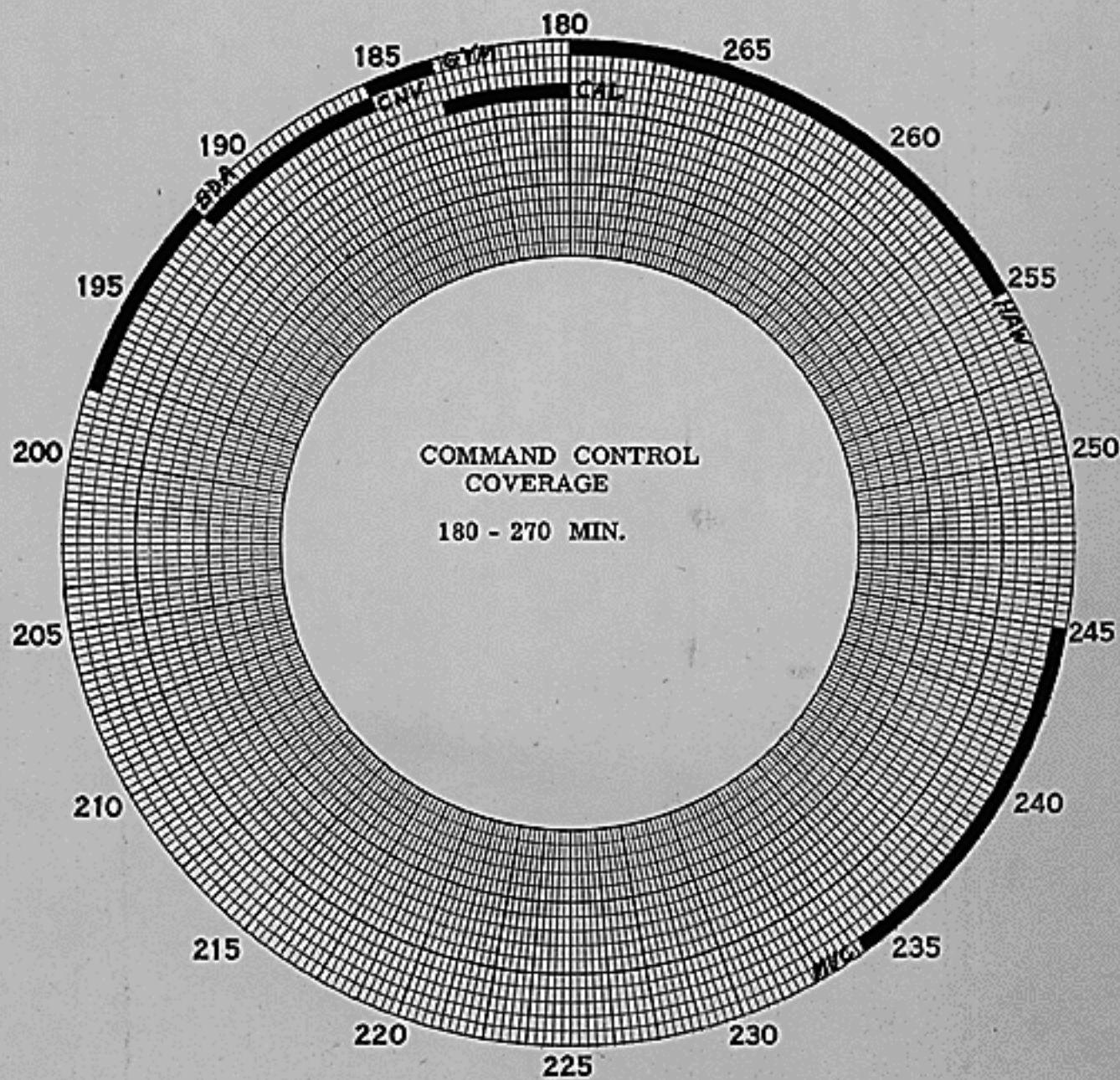


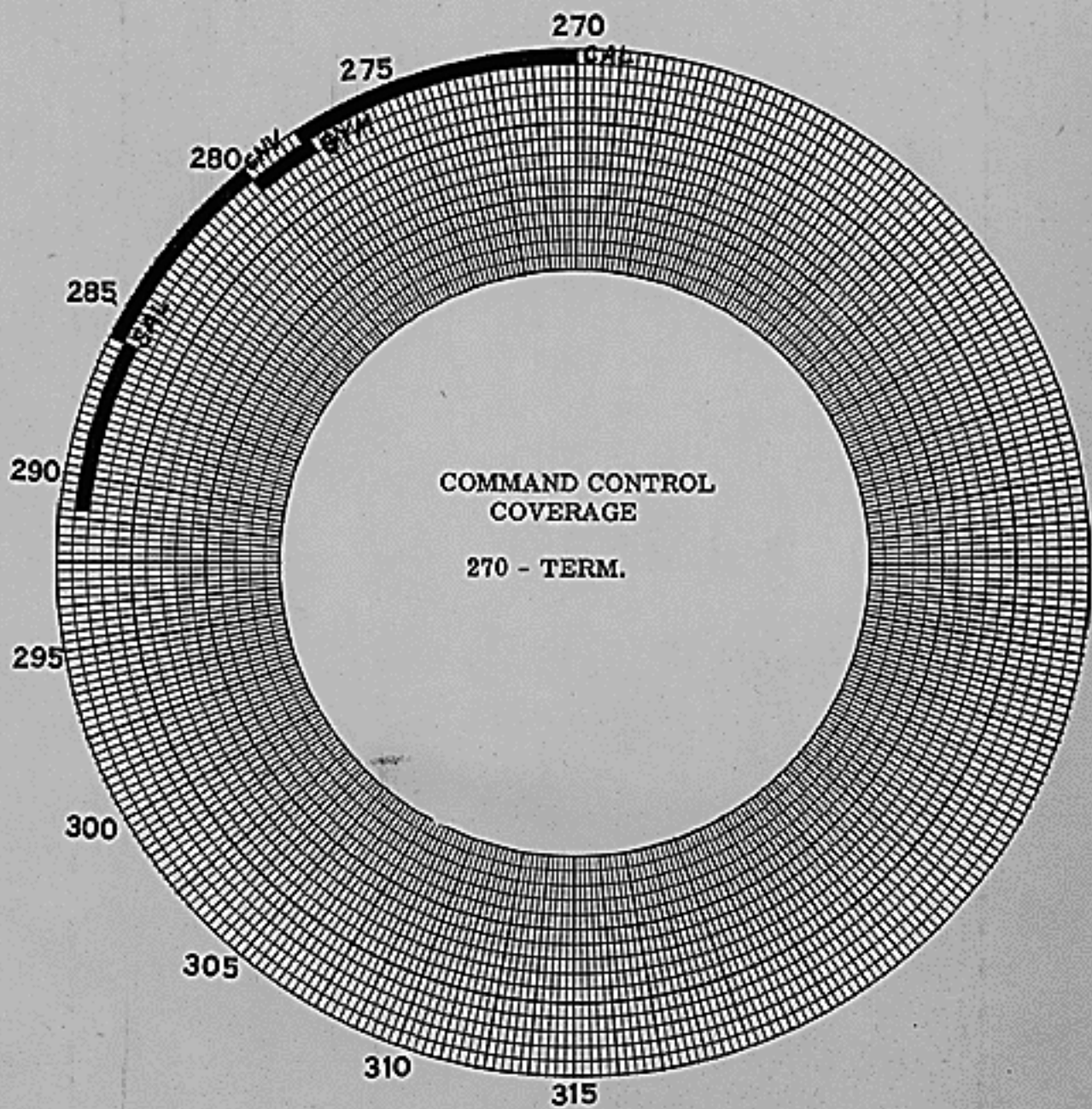


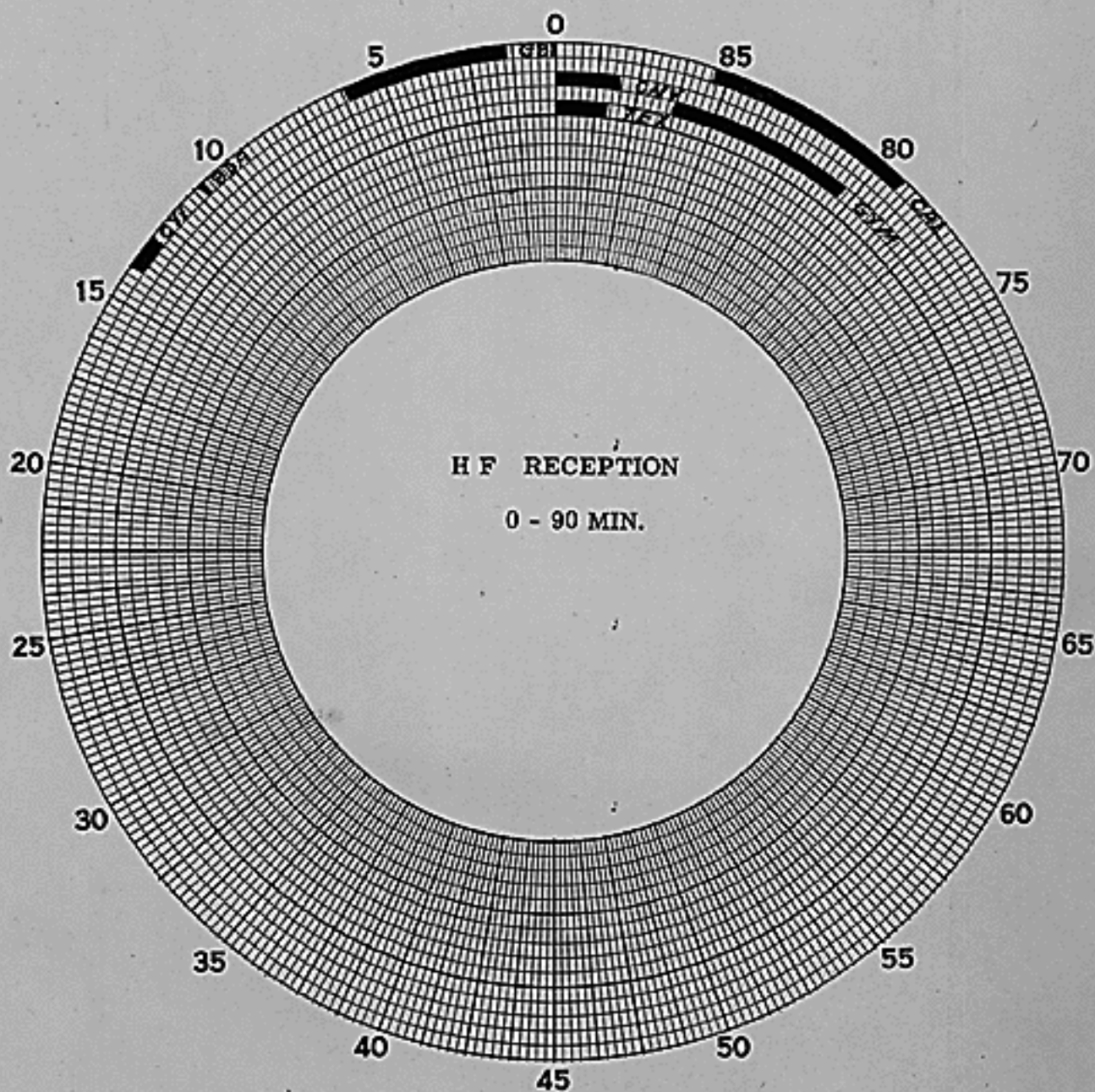


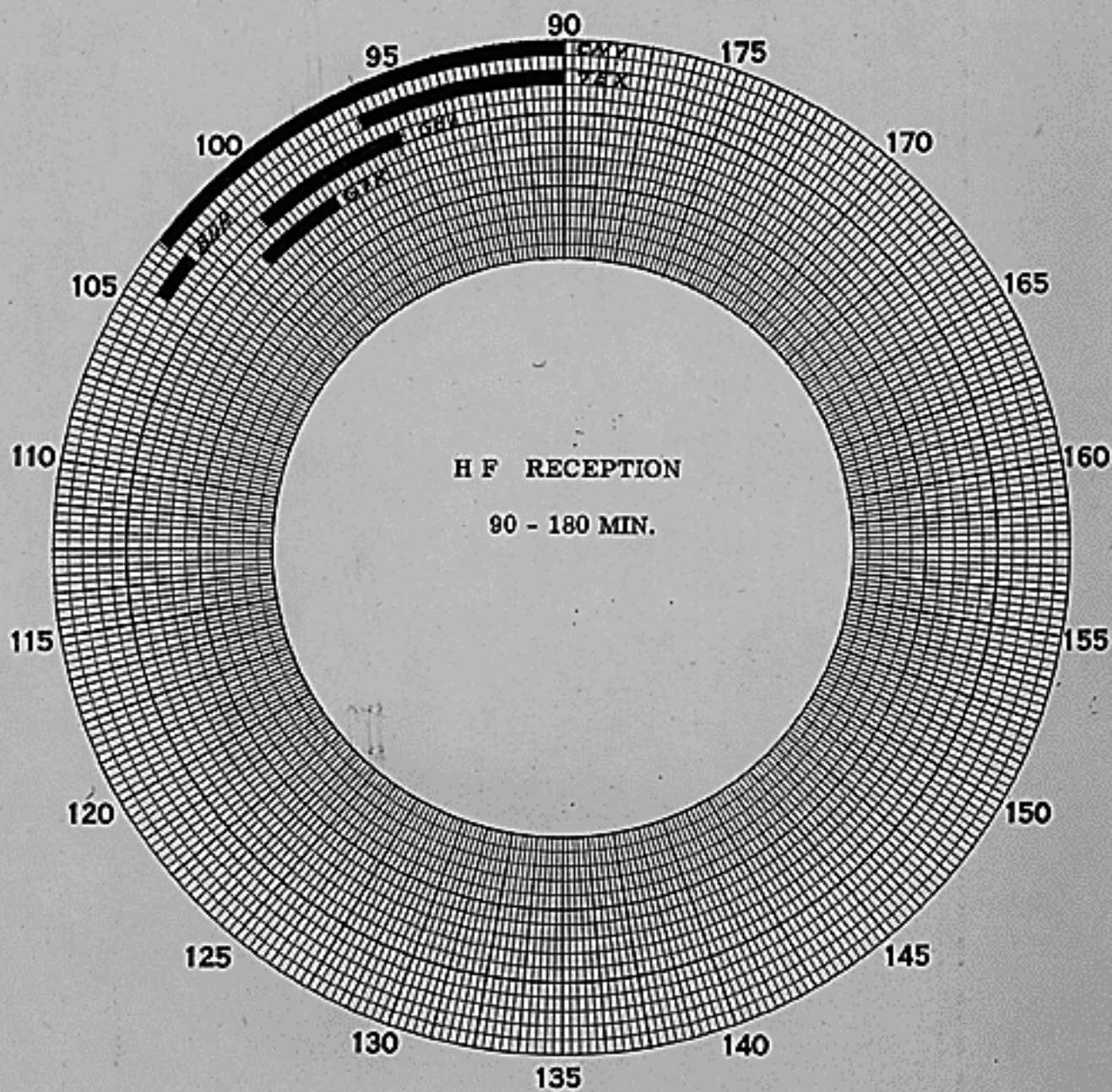


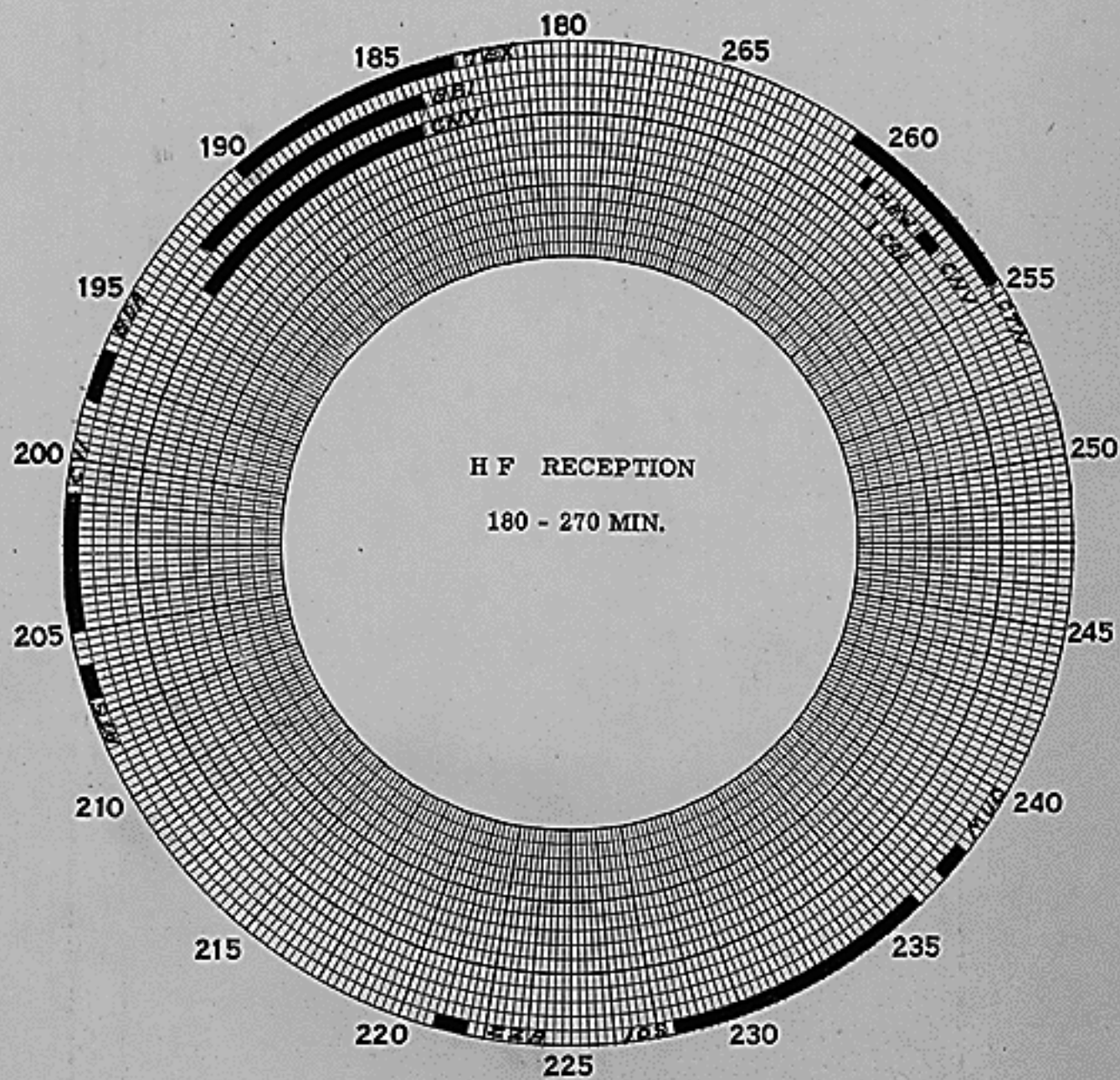


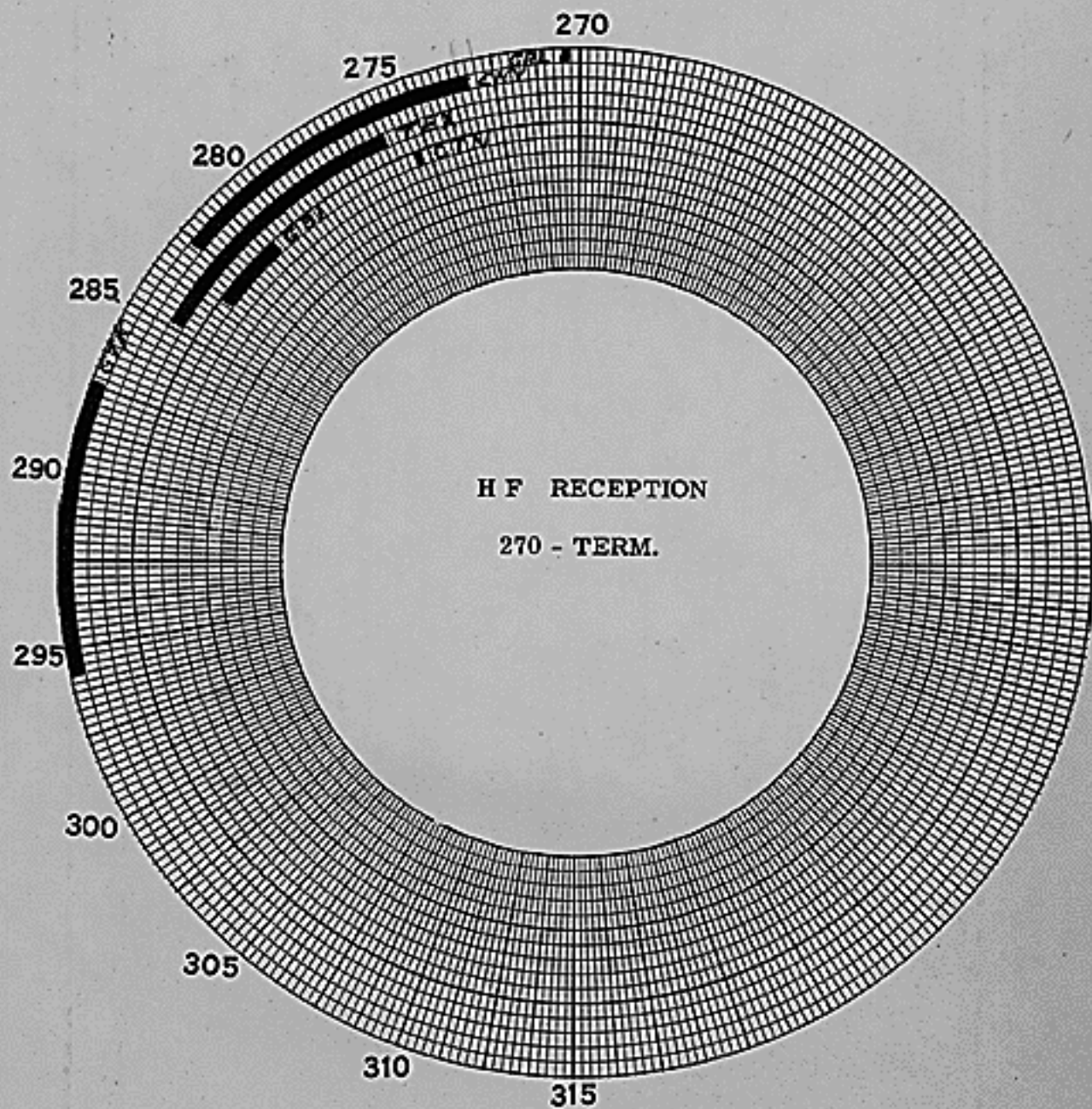


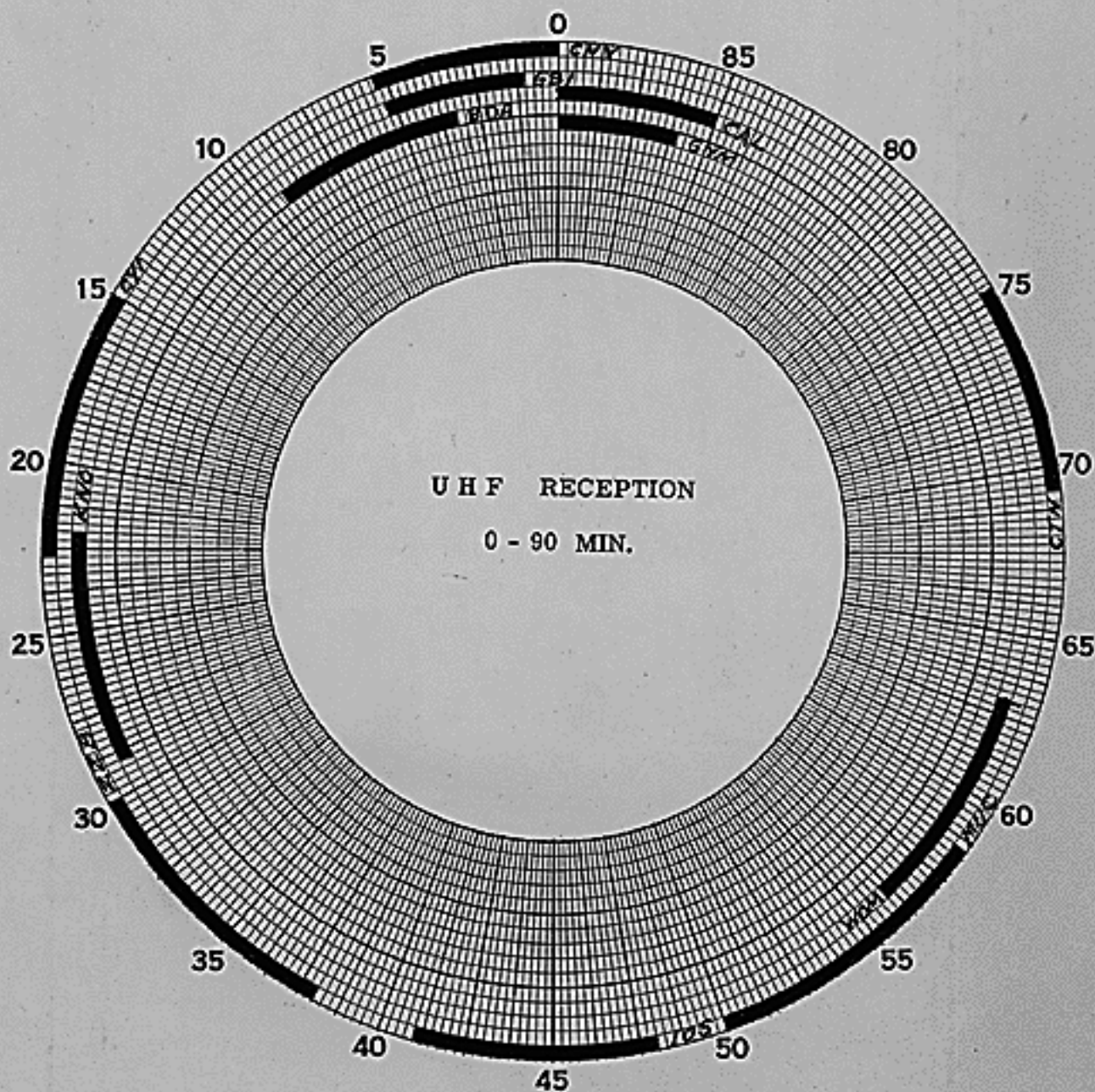


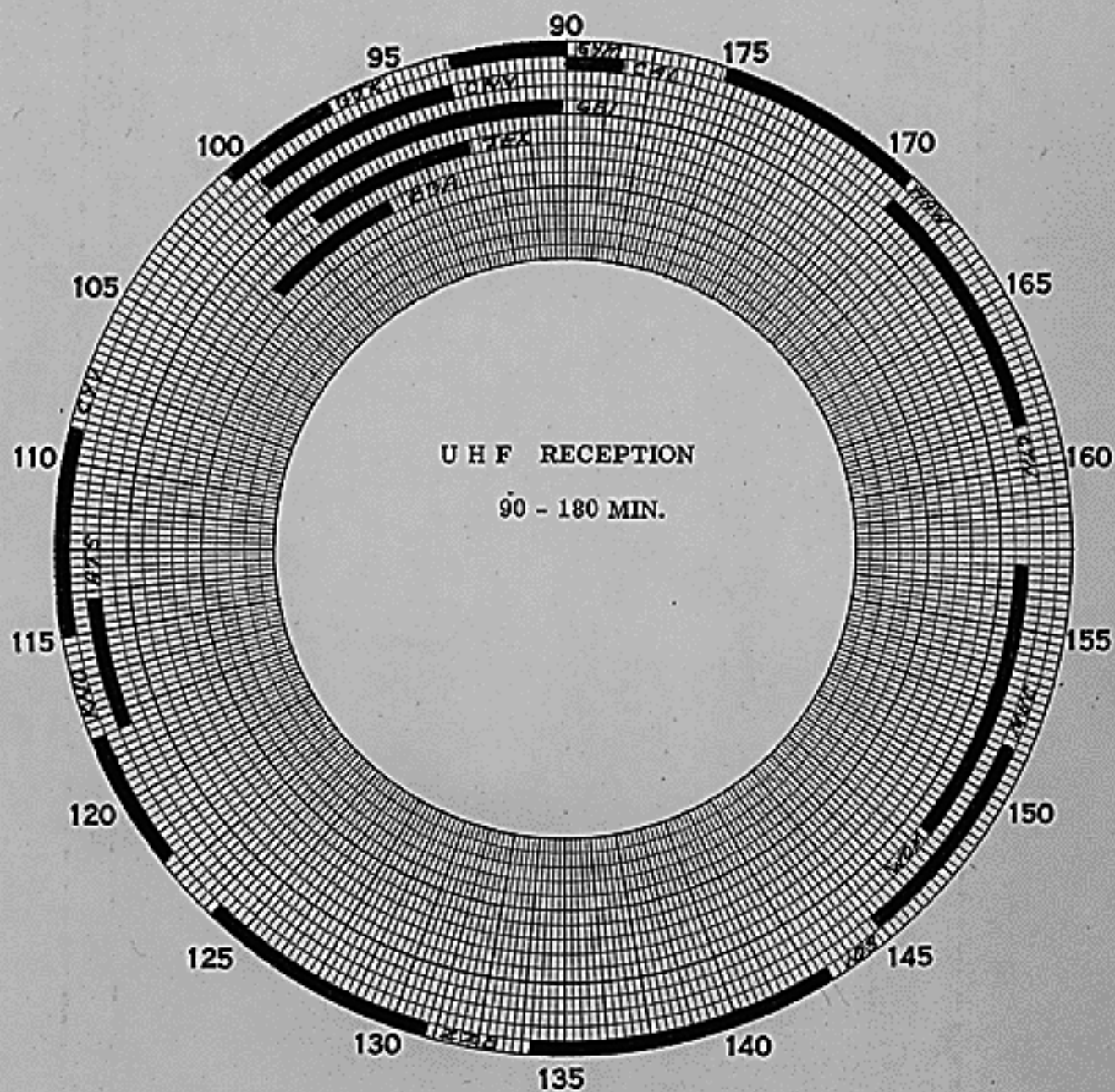


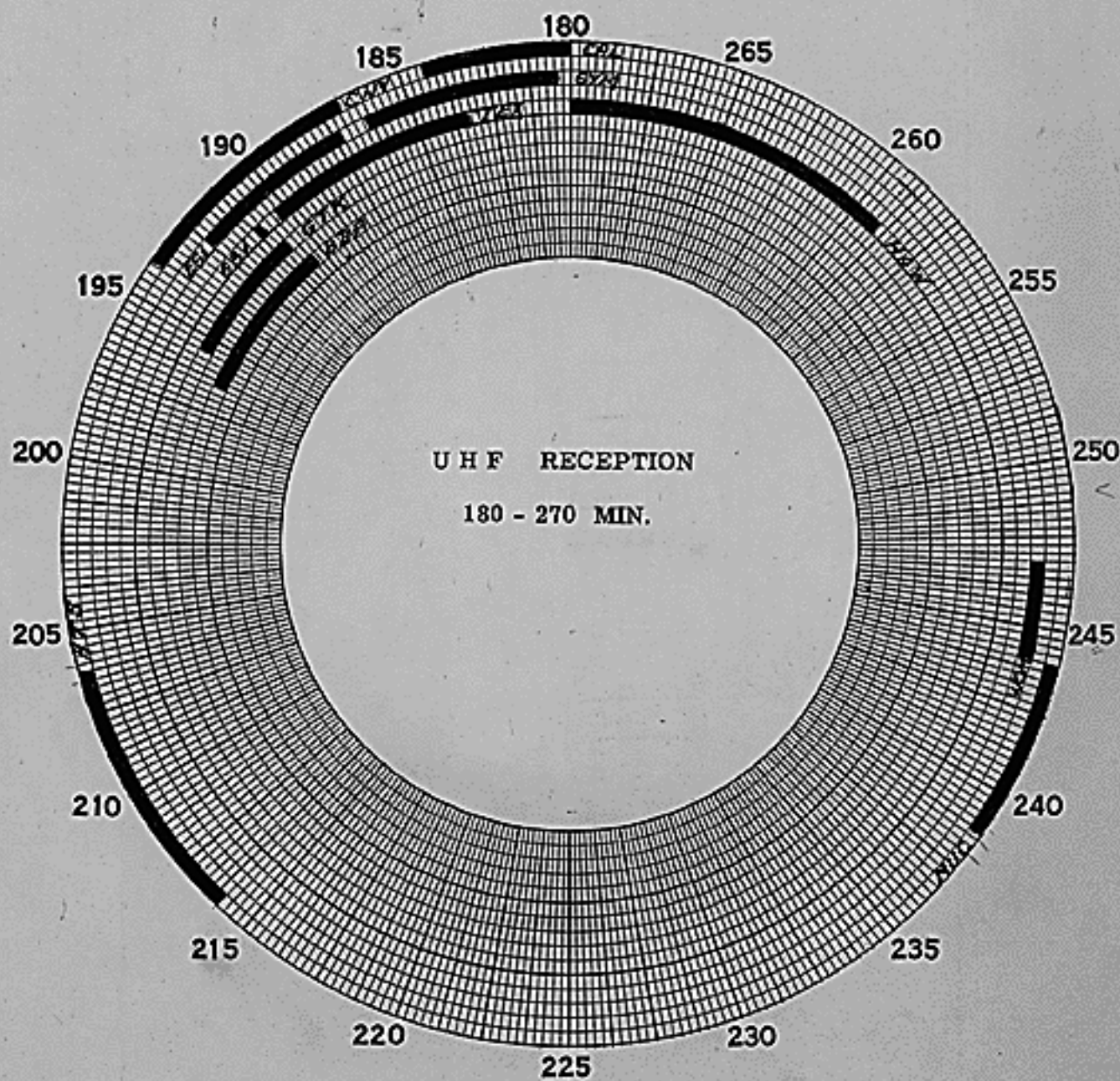


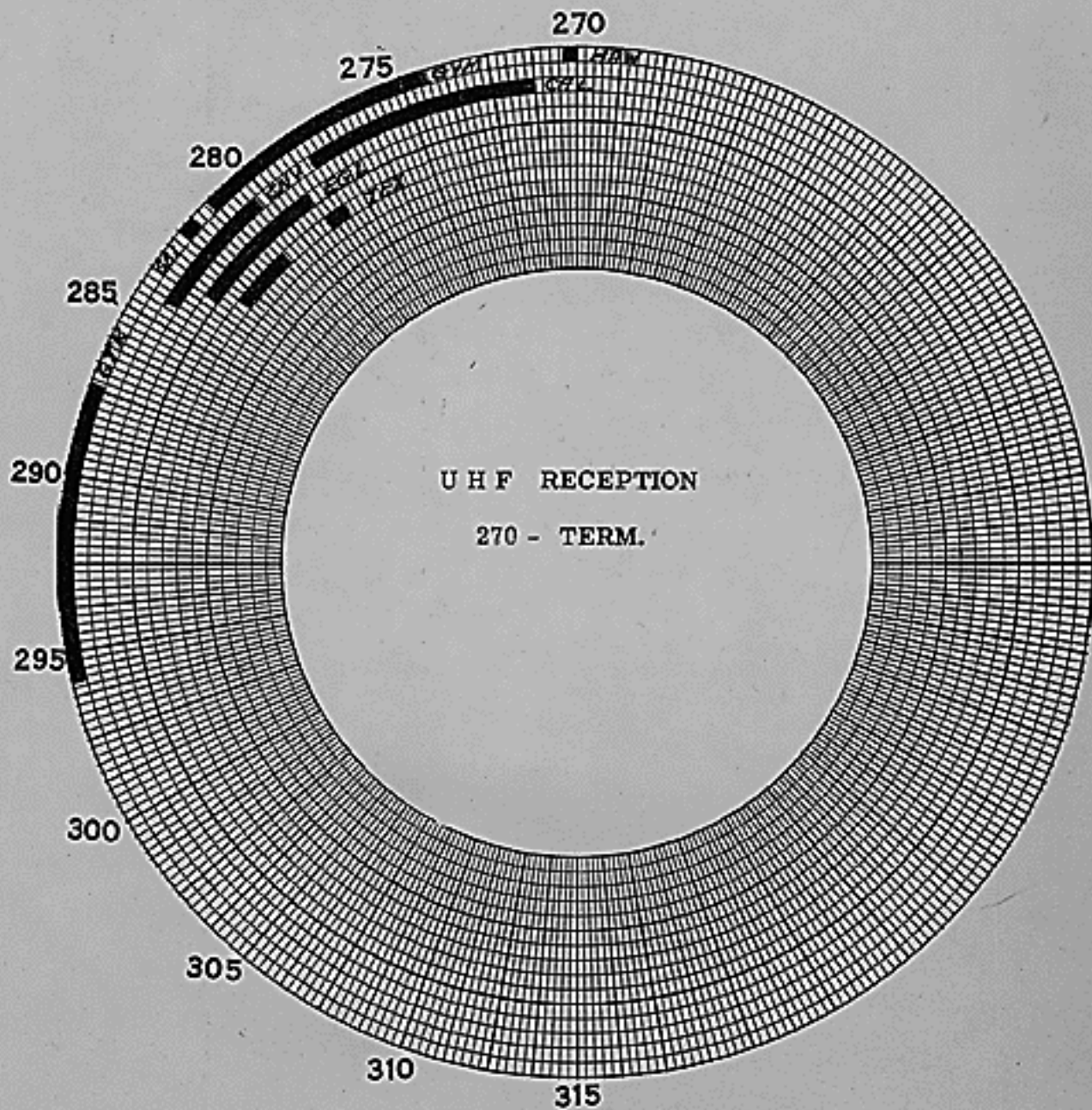












IV. POST LAUNCH INSTRUMENTATION SUMMARY MESSAGES (BY STATION)

A. PRELIMINARY ESTIMATE OF COVERAGE

See Part III

B. INSTRUMENTATION PROBLEMS

CNV - No discrepancies - Negative malfunctions

MCC - No discrepancies - Negative malfunctions

GBI - Radar 3.16 was phased into wrong slot when phasing control on launch radar 1P.16 saw a transmitter pulse on 142 PRF within 5 MCS of Station 3 skin frequency. Later checks of drift rate confirmed that Station 3 had not been out of position prior to phasing action. Lack of rabbit identifier hindered acquisition during launch phase. No other system problems were experienced.

GTK - Could not acquire beacon track due extended range, reentry problems and weak beacon reply.

BDA - First Pass - C-band beacon unstable. It appeared that Cape 16 rabbit identifier was not functioning causing a delay in BDA acquiring C-band track. Interference was reported on TM HI at T plus 1026 but did not degrade data.

Second Pass - Verloft track rough in azimuth unable to find any trouble with equipment. Third pass track was normal.

Third Pass - There were no problems.

CYI - Radar data plotboard developed intermittent trouble three minutes before 2nd pass acquisition. This was remedied before horizon time and normal operation resulted.

ATS - Pen #2 of Aero-Med Sanborn slipped on mounting shaft during orbit two coverage causing pen to show full scale depletion. Pen was reset and tightened after the pass and operated properly during orbit two coverage. Loss of recorded

data on segment #12, secondary oxygen. This parameter was monitored in real time on two console display meters.

KNO - There were no problems.

ZZB - There were no equipment problems.

IOS - HF P/P XMTR caused interference with TM signal for first three minutes of acquisition time on first pass. Transmitter could not be turned down until contact message was sent after confirmation of UHF contact with Astro. All systems AOK on second and third passes.

MUC - Pen 4 of the systems monitors recorder failed during the second pass. This reading was duplicated on the systems panel so there was no loss of data. All other instrumentation operated satisfactorily.

WOM - Magnecorder failed 1448Z repaired 1534Z. No other instrumentation problems.

CTN - There were no instrumentation problems.

HAW - Galvanometer on Aero-Med console became nonlinear during third orbit pass. (Pitch stick position - Gate 24).

CAL - Respiratory trace unusable - Capsule problem.

GYM - Acquisition aid, Sanborn fuse at start of Pass 2. Trouble was located and repaired in about 3 minutes. No other problems.

WHS - Problems TM HI interference prior to first pass. Problem resolved.

TEX - Radar countdown experienced when sharing with Eglin commencing 1620:36Z.

EGL - No instrumentation problems. Some HF and TM interference at start of count. Eliminated by local FMIC. Only failure was M & O tape recorder.

C. MONITORING

CNV - No comment.

MCC - No comment.

GBI - Capsule HF and UHF communications systems were good. Capsule telemetry was good although blackout without reacquisition was experienced on reentry phase. C-band beacon good although was apparently blacked out on reentry until just prior abeam. During launch phase C-band beacon dropped out completely at 1452:47Z. Dropout was abrupt. Capsule S-band beacon was considered below average performance. Radar 3.1 failure to acquire track, was due in part to high angular rate.

GTK - No comment.

BDA - First Pass - All capsule systems performed normally. Capsule separation on at 5 plus 05. Periscope retract on at acquisition. Roll ignore on at acquisition - off after turn around.

Second Pass - The trend in decrease of secondary 02 continued. Thrusters problem continued. All other systems were normal.

CYT - All capsule systems functioned as expected. No event lights observed.

ATS - Second Orbit. Decided fading of HF/UHF signal was noted while Astronaut performed 180 degree Yaw maneuver. Third orbit. At contact Astronaut oriented to 000 and reset gyros. After LOS voice contact again indicated that capsule view did not agree with capsule instruments and station TM. Playback of tape indicated that SEG 51 indicated 84 PFS continuous during Pass 2 and 3. The output from the respiratory sensor was not sufficient to give a reliable readout on the Aero-Med recorder.

KNO - On first pass capsule systems were OK. Inverter temps were a little high and Astronaut was informed. On second pass Astronaut was just completing his 180 degree YAW maneuver and was coming back manually to orbit attitude

on acquisition. He tried to go over to ASCS in orbit attitude BU suspected his YAW was drifting. Our TLM showed him rock solid on YAW at zero degrees. He was checking this when site lost TLM and voice. During this pass Astronaut reported by voice that his right low thruster was not giving control. Low thrust control to left OK on receipt of MCC 20/1658Z referring 0 SEG 51, we checked 100 event recorder and found 83 percent signal on this segment occurred at LOS. Message from MCC was not addressed to us and we received MUC 20/1714Z saying no signal on his segment.

ZZB - Event recorder showed landing bag deployed for entire second pass. No other events monitored.

MUC - No telemetered sequence events noted at this site. During passes at this site all capsule systems operated nominally with the exception of the discrepancy between roll scanner output and roll gyro readings of eight degrees on the first pass and twenty degrees on the second pass and a discrepancy between the pitch scanner output and the pitch gyro reading of seven degrees on the third pass, and a reading from telemetry segment #51 of zero percent during second pass and eighty-five percent during the third pass there was also a discrepancy on the third pass between the telemetry readout and the Astronaut readout of 10 degrees higher cabin temperature on telemetry and 5 degrees higher suit temperature on TM.

WOM - During the first pass all systems appeared green with the exception of the environment systems. TM was solid and strong throughout pass. The respiratory rate was difficult to read because of excessive Astronaut talking. All capsule readings with exception of high inverter temperatures and cabin temperature were normal. UHF and HF communications were normal. Astronaut performed 30 minutes check and results of all physiological tests were good although the bungee cord exercise was not performed.

During second pass control systems problems in the FBW and ASCS occurred. The Astronaut reported the ASCS could not maintain orbit attitude for the capsule drifted from right to left YAW. The FBW mode was also not

functioning in the right low YAW thruster. Inverter temps had increased to the 200 degree level but were not critical. Again TM was solid and all data with exception of respiration rate was readable. The clocks were reading solid but the CET was reading one second slow. Due to Astronaut's concern over control system problems the 30 minute check was not completed. Astronaut's status was excellent and we were still GO for the third orbit.

The third pass resulted in a few minutes of solid TM with no appreciable changes in capsule status except increased inverter temperatures. Astronaut's status was good.

CTN - YAW left 1 pound thruster failed. This affected both ASCS and FBW. From information received at CTN no reason is clear why Astronaut could not have controlled left YAW with man proportional with ASCS controlling all other axes. Inverter temperatures increased to values which were expected if cold plates did not operate. All other systems performed well. No events were recorded at CTN.

HAW - First Orbit - No contact.

Second Orbit - There were no significant changes from previous reports on performance of capsule systems. Inverters continued to read approximately 190 degrees and 200 degrees. The Astronaut reported he had positioned the capsule in a zero-zero-zero attitude and caged the gyros; however, the gyros continued to drift particularly in roll. Capsule attitudes were compared with ground readouts and were in reasonably close agreement. Astronaut could not determine drift rate.

We had patched SEG 51 into the X-Y plotter and during the pass this signal came on at 82 percent level. Time of occurrence was 1738:36Z (Get of 025057) approximately two minutes after acquisition.

Third Orbit - Immediately after contact requested Astronaut to place landing bag switch in auto position and see

if the landing bag light would illuminate, indicating the landing bag had deployed. We then requested the Astronaut to change the clock by one second to 043237 which he did. Astronaut then reported the ASCS to be operating reasonably satisfactory with some drift in YAW axis. Inverter temperatures were up to 225 and 212 degrees and this information was passed on to the Astronaut. The Astronaut was in the middle of a GET time hack when voice was lost. The time check was not completed successfully and we advised CAL that Astronaut would probably want this upon contact.

CAL - First Pass - Good UHF, TM, FPS-16 track. Astronaut status one. All systems looked good except YAW was drifting in ASCS mode. 150VA invert temperature 200 degrees.

Second Pass - Good UHF, TM, C and S-band track. Astronaut status one. Capsule-ground gyro readouts had good correlation. 150VA invert temperature rose from 215 to 220 during pass. SEG 51 read 85 percent throughout pass.

Third Pass - Good UHF, TM, C and S-band track good after retrofire but capsule comm could get no useful information from plotboard. Retroseq by clock at correct GMTRC. DC current peg at GMTRC. Delta V 400 FPS. Some YAW deviation during retro but capsule within limits. Man control was required to hold attitude. Astronaut status one. Pulse to 105 at retro, 85 at LOS. 150 VA invert temperature 240 degrees. 250 VA invert temperature 230 degrees. Fuel usage 42 to 30 auto, 40 to 25 manual. Fuel line temperature dropped 15 degrees when used. Retro temperature to HHH at retro.

GYM - Comments on the performance of all capsule systems monitored, etc. A 30 percent level signal of scope retract was observed on all three passes. This was confirmed by visicorder. On the first pass over GYM Astronaut reported that the capsule while on ASCS was drifting right YAW about 20 degrees. He made corrections on man. It again drifted when he went back to ASCS. Retro CMD, Retros 1, 2 and 3 ON.

WHS - N/A

TEX - Capsule systems - Minor ASCS malfunctions: This site received an anomalous landing bag deploy signal on SEG 51 2nd and 3rd pass; retro time (SEG 50) shown on systems recorder was plus 8 minutes.
At 19:29:14Z (22 PFS)

EGL - None.

D. GENERAL COMMENTS

- CNV - Equipment performance satisfactory. Mission procedures proved sound and effective.
- MCC - Equipment performance satisfactory. Mission procedures proved sound and effective.
- GBI - Mission and equipment performance considered normal. Radar 3.16 did experience angle rates during reentry which appeared to be in excess of the DTS capability. Command control operated satisfactorily but was not used. Supervisory control operated to select as required. No HF or UHF transmissions to capsule were initiated by this Station. Systems were selected by Cape and operated satisfactory.
- GTK - Capsule comm relay worked very well.
- BDA - The countdown proceeded normally with all systems in a GO condition until about T-12 minutes when a power surge automatically shut down the computer. The automatic switches were bypassed and the computer was started again. A hold of about 2 minutes was called at T-06 plus 30 in order to complete a B-Sim. run which was successful. Acquisition was excellent on all ground systems during launch. All capsule systems were normal and a GO condition was obtained at about 05 plus 15. The value of V/VR rapidly converged to 1.0002 with a value of ECTRC for 1 bravo of 17 plus 30. Following this time, all passes over the station were normal except as noted and all ground systems tracked well. Answered reports for all passes were normal in all respects.
- CYI - The mission went extremely well at this station. Reduction of data from the second orbit confirmed however that event on SEG 51 had occurred from acquisition and solid on both HI and LOW for entire pass. This event had not occurred on the first orbit however. Also during the second orbit there was observed an intermittent roll ignore. The Goddard loop improved

as mission progressed. UHF was excellent during the first and second pass both in reception and transmission. HF on third orbit was loud and clear at this Station. The flight plan was followed closely with a few minor exceptions. On first orbit blood pressure when asked (about one minute behind schedule) stated he was repeating test. Some deviations were noted during the day horizon check which were confirmed by TLM attitude readouts and stick movements equipment: GET was erratic in negative time but performed correctly in positive time. All subsystems support of the mission was very satisfactory which gave flight controllers added confidence. No significant deviations from flight plan occurred from medical standpoint. Astronaut was quite cool and calm on every pass over Station and each time appeared to be confident and assured. All physiological parameters remained within normal limits and reflected no stress.

ATS - Performance of all site personnel was excellent. With time exception noted in Section B, equipment operation was highly satisfactory.

KNO - Equipment and personnel performance excellent.

ZZB - On orbit one all capsule systems functioned normally. Inverter temperature were steady over Station with fans inverter reading 190 and ASCS inverter 155 degrees. Flight plan was followed and Astronaut readouts agreed with TM. Both TM and Astronaut reports indicated capsule and Astronaut were GO. Astronaut reported cloud cover over East Africa with some clear areas where he could see ground.

On orbit two, all systems were good except ASCS was not holding good limits in YAW. Astronaut reported the right low YAW thruster was not operating which was the reverse of low left YAW thruster reported by previous sites. The inverter temperatures were again steady but reading 205 degrees on fans

and 192 degrees on ASCS. Astronaut reported watching the sunset at same time TM was indicating pitch IG. This could mean that the scanner was looking at the sun causing the pitch IG. After replaying tape it was discovered that SEG 51 landing bag deploy was reading 85 percent for entire pass. However, Astronaut reported landing bag switch off.

On orbit three HF contact was established for 1 minute and Astronaut reported that control system was ASCS on all three axes with manual backup. The Astronaut's status was excellent for entire mission.

IOS - No comments.

MUC - In general, all systems at this site were very good.

WOM - No comments.

CTN - The mission went exceptionally well. Outside of the drift problem with the backup 10.5 discriminator, which did not detract from the operation in any way, all equipment functioned in an excellent manner.

HAW - The mission from the viewpoint of this station went very well. Several cases of interference were noted but with no serious consequences except on the first orbit. On the first orbit severe HF interference was experienced and we were not able to establish HF contact with the capsule.

Site equipment performed well and support to the Flight Control Team by the M & O Team was excellent.

CAL - All site equipment performed well. Mission "GO" at CAL for orbits one and two. Reentry initiation and retrofire appeared close to nominal on 3rd pass.

GYM - Astronaut observed, as he came over GYM on the first pass, that small particles were floating along with him. Some of the particle had a velocity with respect to the capsule of about 3 ft/sec. He reported that he saw thousands of these particles before he arrived at GYM.

WHS - First pass - Tracked rabbit then switched to proper return. This caused possible loss of approximately 18 valid data points, TM signals good, TM hi best. C-band beacon good. Slight skip momentarily after retrofire. Beacon SS 40 DB above noise. No problems during passes.

TEX - No G/A transmissions from TEX 1st orbit. All ground systems normal operations entire mission.

EGL - Very fine C and S-band radar track for all passes. Valid data lines obtained follow:

	<u>PASS 1</u>	<u>PASS 2</u>	<u>PASS 3</u>
MPQ-31:	Site 18 to GSC 0	Site 44 to GSC 14	Site 41 to GSC 20
FPS-16:	Site 38 to GSC 36	Site 36 to GSC 36	Site 24 to GSC 23

Secondary data to CADDAC was used for Canaveral radar acquisition for Pass 1 and Pass 3. Cape did not use for Pass 2. Good acquisition aid track for Pass 1 and 2. Rough for Pass 3. Fine C-band secondary data plot obtained for all passes. Composite TM recording made during lift-off and all passes. Continuous HF recording from lift-off to splash (some parts very good). UHF recording not usable (Pass 1), noisy and weak (Pass 2) and good (Pass 3). Hear downrange EGTR sites made some good UHF recordings - will investigate. AM proud of Eglin performance.

GSC - GENERAL - All regular, part-time and backup circuits in support of mission critical coverage confirmed from all sites propagation prediction was U4-Fair and improved during mission. All communications were in effective support during entire mission.

TTY SYSTEM - Circuits: Support good. Relatively few outage periods. Propagation caused sizeable loss of ATS useful circuit time but ATS was able to support mission events. CYI lost about an hour prelaunch at 0600Z. BDA - 30 between 1319Z and 1340Z had intermittent outages until channel substitution was made. Eglin (08) had hits during 3rd pass radar transmission.

EQUIPMENT - Fair. Nine trouble cases at GSC for the five after lift-off, expeditious handling resulted in restoration in less than 9 minutes. Minimal service impairment through protected delivery.

TRAFFIC LOADING - Traffic flow exceptionally smooth. Large portion went through whole system with no delay. Waiting periods generally less than one minute.

RADAR DATA - 2048 lines of radar data received from all sites on three passes with only 15 lines in error in transmitting this information to the Goddard computers. Eglin accounted for 9 lines. HAW on second pass not accepted by computer on manual insertion because of defective switch on ASR.

ACQUISITION - All acquisition messages before retro-fire dispatched to sites in time for appropriate use. After retrofire several messages generated to late for use by site. As follows:

<u>DTG</u>	<u>SITE</u>	<u>FIRST LINE</u>
192400	CAL	191928
192418	WHS	192233
192700	EGL	192716
192718	CNV	192856
193203	CNV	192856

VOICE SYSTEM - Very good support by the voice network and exceptional fine performance was possible in the numerous air-to-ground connections to the ground network. CYI voice was good for mission contact times though it went red for four minutes after retrofire. Echo was reported on GYM line before lift-off and found to be a speaker feeding back into the system. CAL also had some echo on first pass but action was taken to clear by alternate routing high speed data system.

HIGH SPEED DATA - Data transmission OK in both directions. Rated excellent by all concerned. With low error rate prior to and during the launch GD1263 circuit levels required correction at the start of the countdown by telco. Northbound circuits:

Circuit levels differed between IP 7090 and GE Burroughs source with GE source low level but usable. Scheduled post mission effort will correct this problem.

CKT GD 1262 from IP 7090 operated at 3.6V/4.8V data/Sync amplitude to correct sync error tendencies of this circuit. Southbound: Rated AOK during entire mission after GD 1263 cut. Level corrected.

RADAR DATA RECEIVED AT THE GODDARD COMPUTER

<u>STATION</u>	<u>RADAR</u>	<u>OBSERVATIONS</u>
BDA	C	44
	S	--
CYI	S	50
MUC	S	50
WOM	C	40
GYM	S	44
WHS	C	28
TEX	S	34
EGL	C	38
	S	--
CNV	C	35
BDA	C	42
	S	8
CYI	S	34
MUC	S	50
WOM	C	29
HAW	C	15
	S	22
CAL	C	28
	S	5
GYM	S	--
WHS	C	31
TEX	S	47
EGL	C	36
	S	12
CNV	C	44
BDA	C	49
	S	1
MUC	S	50
HAW	C	38
	S	12
CAL	C	17
	S	7
GYM	S	--
WHS	C	34
TEX	S	41
EGL	C	18
CNV	C	22

MAR 16 1962

Kraft
Revised
CKL

MEMORANDUM for record

February 28, 1962

FROM: James J. Donegan

SUBJECT: Computing Notes on MA-6

The computer system at Goddard performed well during the MA-6 mission. The orbit was well defined and quickly determined. The Goddard equipment, the launch subsystem and the high-speed lines worked well during the entire mission. The performance of the Mercury Tracking Network during all phases was excellent. The radar tracking data received was exceptionally accurate and plentiful.

During the launch the data received from the Cape sources was continuous and of good quality. The insertion conditions were nominal, resulting in a strong GO decision. The GE/BURR data showed close agreement with IP7090 data. Although a minimum seven orbit capability was indicated we computed the capsule actually had a lifetime of greater than 60 orbits or 4 days. (after 4 days and 60 orbits the perigee height had decayed 9 miles). Lifetime computed was 79 orbits, 4 days and 22 hours.

The orbit computation functioned normally and automatically during the mission. GMTTC for end of mission varied a maximum of 2 seconds after the Bermuda correction from launch. Tracking data was received from all sites. Two items caused us some concern. The first a malfunction of the off-line computer during the second orbit. The computer was restarted in two minutes and had a full complement of data by 4 minutes. The second item was the failure to process the Corpus Christi data. The data was received and checked on the "C" computer but not used by the operational computers. The problem is being investigated.

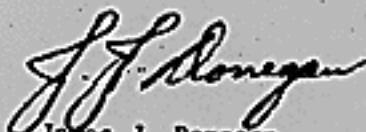
Time to fire retros was computed on the basis of impacting at a longitude of -68° . Immediately after retro-fire the Ft. Arguello tracking data gave us an impact longitude of -68.92° which was refined to -68.88° using White Sands, Texas, Eglin and Canaveral FPS-16 data. The re-entry computation was automatic.

Attached is a brief summary of some of the pertinent information gathered by the Goddard Computing system during the mission. Included are the following:

- a) Goddard Computer Pre-Flight Log
- b) CADFISS Support Summary
- c) Summary of Launch
- d) Resume of Goddard Flight Director's Report
- e) Summary of Radar Data Used
- f) Summary of Impact Point Computations
- g) Summary of Acquisition Data Sent
- h) Orbital Elements
- i) Description of Bermuda Computing System Performance

Subject: Computing Notes on MA-6

This information represents the first "quick look" at the data. It will be revised by a more accurate analysis which is presently going on.



James J. Donagan
Data Operations Branch
Manned Space Flight Support Division
Goddard Space Flight Center

Enclosures: As Noted

JJD:adw

(Figure 1 of the Launch Program Section is omitted due to classification)

NCG-419 F-0 DAY

February 20, 1962

19/2130

CE's on A&B system
WWV time standards manned.
Diesels manned.
A/C and Electrician on stand-by.

19/2310

A&B system checks completed. Both systems AOK.
KE's beginning in-house checks.

19/2350

KE in-house checks completed. All systems AOK.
Begin GSC/CNV interface tests.

0035

1263 south released due to high level. 5 V
data and 6V EOW. Trouble lies between Washington 1
and Cocoa Beach.

0106

Washington 1 returns 1263S. Adjusted between
Orlando and Cocoa.

0110

	<u>NORTH</u>		<u>SOUTH</u>	
	DATA	EOW	DATA	EOW
1262	2.5 V	3.0 V	1.7 V	2.6 V
1263	2.5 V	2.8 V	2.9 V	3.5 V
1264	1.0 V	1.3 V	2.4 V	3.0 V
1265	1.7 V	1.8 V	2.2 V	2.5 V

0120

KE GSC/CNV interface checks completed. Everything
is nice and GREEN. Stand by for H.S. roll call.

0130

High Speed Roll Call started.

0140

BDA reports all systems and radars GREEN.

0150

High speed roll call completed. All tests passed
with excellent scores.

0225

Load "B" computer for AMR slews.

0230

Begin slews.

0245

Slews completed. All looked good. CADFISS making
in-house run in preparation for short roll call.

0300

CADFISS cues being transmitted.

0335

CADFISS completed. Now running histan.

0400

Load operational program for T-175 trajectory run.

0405 Trajectory run started.

0415 Load "A" for AMR slews.
Load "B" for radar data flow test.
CE's on "C" computer.

0445 Slews completed. GBI, SSI, and CNV look good.

0500 Begin radar data flow tests.
Thirty (30) minute built-in hold now in effect.

0516 Radar data flow completed.

0530 Extend hold additional 30 minutes for booster.

0600 Extend hold an additional 15 minutes.

0625 Count picked up at T-120.

0635 Ran B/GE data link test.

0650 Load operational program for T-75 run.

0705 Begin T-75 trajectory run.

0725 Hold, estimate 30-60 minutes for broken hatch bolt.

0805 Resume count at T-60.

0810 Run data flow.

0820 T-45 and holding for booster refuel.

0825 Data flow complete.

0835 T-45 and counting.

0850 B/GE data link test started.

0858 T-22 and holding.

0900 B/GE data link test complete. Excellent results.

0923 T-22 and counting.

0930 Cycle "A" computer.

0931 Cycle "B" computer.
Data select reports both computers cycling-signals received AOK.

0933

BDA reports loss of power on computer. Will count to T-7 and hold if BDA not restored as yet.

0939

T-6:30 holding approximately 5 minutes for BDA to run confidence check. Power now restored.

0941

T-6 and counting.

L.O. 14 47 39

Mission going very well.

Retros fired 19 20 472

Mission completed.

PRELIMINARY REPORT OF THE CADFISS SUPPORT FOR MA-6 ORBITAL MISSION

Four CADFISS test runs were performed in support of the MA-6 launch day countdown. These runs were as follows:

RUN 1. CADFISS tests with Mercury sites of the Atlantic Missile Range and Goddard's ASR-140 and 141 Teletype equipment.

RUN 2. CADFISS site tests with the entire Mercury range.

RUN 3. Radar Data Flow CADFISS tests with Mercury radar sites, including reruns of radar failures from RUN 2.

RUN 4. Radar Data Flow CADFISS tests with Mercury radar sites, due to an extended hold in the count.

All CADFISS tests were started on time without any computer troubles, and finished in the allotted time in the countdown. As a result of these CADFISS tests, a high level of confidence was established in the ability of the Mercury range to support the mission. A detailed analysis of the data received during these tests is now in progress, and a report of the findings will follow.

LAUNCH PROGRAM

The Goddard launch computer program functioned perfectly for the MA-6 mission.

Input data received from the Cape was continuous and of good quality. Only seven data messages out of a total of 1254 (2/sec. over duplexed lines) transmitted over line 1 (GE-B) were tagged bad or missing during the time interval from liftoff through the GO-NO GO computations. Likewise, only ten data messages out of a total of 1568 transmitted over line 2 during the lift-off through GO-NO GO time interval were tagged bad or missing.

No spurious T/M or discrete event information was detected. Table 1 shows the events together with their time tags. One question concerning T/M and discrete event information arises. CAPS has a time tag which is 7 seconds later than SECO. This time difference is greater than expected. Also, during the debriefing immediately following the mission it was understood here at Goddard that GE-B time tags on SECO and CAPS were 14:52:40 and 14:52:42 respectively; a difference of only 2 seconds. The question will be further explored.

Line 2 was the selected data source for Goddard output computations for the first 71 seconds after liftoff and line 1 (GE-B) was selected for the remainder of the launch phase, including the GO-NO GO. Plot board one showed that a near perfect "bullseye" had been scored at engine cutoff. Verification of a solid "go" appeared from the on-line print. Table 2 shows the computed velocity magnitude was approximately 9 ft/sec. under the nominal and flight path angle was approximately $-.067$ degrees from nominal. Computations of velocity and flight path angle using IP 7090 (non-selected source) data showed close agreement with computations on GE-B data. The computed GMTRC of 15:05:46

to land in contingency area 1B differed from the orbit computations using numerical integration by only 5 seconds after the Bermuda differential correction.

Figure 1 shows the 20 computed velocity magnitudes from which the V average was obtained. The difference between the largest and smallest values is shown to be approximately 57 ft/sec. This compares closely to results obtained from the MA-5 mission.

TABLE 1

MA-6 DISCRETE AND T/M EVENTS RECEIVED AT GODDARD

LIFTOFF 14:47:39 GMT

	<u>EVENT</u>	<u>TIME</u> (seconds since liftoff)
	BECO	128.46
	TOMS	155.1
	TOWR	155.1
manually inserted	1 POSIGRADE	169.1
	2 POSIGRADE	169.46
	3 POSIGRADE	169.9
	SECO	300.46
	ABOI	302.7
	CAPS	307.46
	ORBIT PHASE	352.7

TABLE 2

GODDARD ON-LINE PRINTOUT SHOWING RESULTS OF THE GO-NO GO
COMPUTATIONS FOR THE SELECTED AND NON-SELECTED DATA SOURCES

NO. PTS. USED	GE-B	IP 7090
	(selected source)	
	20	23
RECOMMEND	GO	GO
GMTRC	15:05:46	15:05:35
VELOCITY	25727.649	25733.319
GAMMA	-.067423968	-.090718389
$V_{AVG} - V_{GO}$	+112.69677	+118.0017

GODDARD FLIGHT DIRECTORS COMPUTER REPORT

Prelaunch:

Both computers cycling

Launch:

"B" computer outputting

A GO decision was recommended by the GSFC computers. The apogee and perigee values calculated were nominal. The $\vec{r}$, $\vec{v}$ vectors turned over to the orbital phase were based on GE/B data.

Orbit:

The "B" computer was the outputting computer throughout the 4 hour 58 minute mission. As an estimate to the goodness of fit the initial corrections to position and velocity are listed for each reporting station. Also the number of differential corrections, applied to each site, are shown.

FIRST ORBIT

BDA -

FPS-16 and VERLORT radar reported
FPS-16 data was used in the solution
The corrections were as follows:

$$\delta r = 2600 \text{ yards}$$

$$\delta v = 5 \text{ ft/sec}$$

Two differential corrections (1 successful)

CNI -

VERLORT data was used in the solution
The corrections were as follows:

$$\delta r = 1395 \text{ yards}$$

$$\delta v = 6 \text{ ft/sec}$$

Two differential corrections (2 successful)

MUC -

VERLORT data was used in the solution

$$\delta r = 419 \text{ yards}$$

$$\delta v = 1.6 \text{ ft/sec}$$

Two differential corrections (1 successful)

WOM - FPS-16 data was used in the solution
 $\delta h = 237$ yards
 $\delta v = 1.6$ ft/sec
 Two differential corrections (1 successful)

GYM - VERLORT data
 $\delta h = 349$ yards
 $\delta v = 1.2$ ft/sec
 Two differential corrections (2 successful)

WHS FPS-16 data
 $\delta h = 28$ yards
 $\delta v = .1$ ft/sec
 Two differential corrections (1 successful)
 (of the 28 valid observations, at least 10 of these had range errors of approximately 400,000 yards. The angular measurements were nominal).

EGL - FPS-16 data
 $\delta h = 167$ yards
 $\delta v = .8$ ft/sec
 Two differential corrections (2 successful)

TEX - VERLORT reported, the computer did not use this data for some unknown reason. (now being investigated)

CNV - FPS-16 data
 $\delta h = 28$ yards
 $\delta v = .4$ ft/sec
 Two differential corrections (1 successful)

SECOND ORBIT

BDA - FPS-16 data
 $\delta h = 17$ yards
 $\delta v = .1$ ft/sec
 Two differential corrections (1 successful)

CNI - VERLORT data
 $\delta h = 70$ yards
 $\delta v = .2$ ft/sec
 Two differential corrections (1 successful)

MUC - VERLORT data
 $\delta A = 350$ yards
 $\delta V = .8$ ft/sec
Two differential corrections (1 successful)

WOM - FPS-16 data
 $\delta A = 210$ yards
 $\delta V = .6$ ft/sec
Two differential corrections (2 successful)

HAW - FPS-16 and VERLORT data received
FPS-16 data was used in the solution
 $\delta A = 223$ yards
 $\delta V = .6$ ft/sec
Two differential corrections (1 successful)

17hr 47min 0sec

The off-line computer ceased operating. A restart was initiated immediately.

17hr 51min 03sec

The "A" computer was again in the computing mode. The only data lost was California data. Muchea data was read into the "A" computer (is) the ASR. This would give a stronger solution because of arc length.

CAL - FPS-16 and VERLORT data received
FPS-16 data was used in the solution
 $\delta A = 488$ yards
 $\delta V = .1$ ft/sec
Two differential corrections (1 successful)

WHS - FPS-16 data
 $\delta A = 209$ yards
 $\delta V = 1$ ft/sec
Two differential corrections (2 successful)

TEX - VERLORT data was received at the computer.
 $\delta A = 350$ yards
 $\delta V = 10.4$ ft/sec

EGL - FPS-16 and VERLORT data received. The FPS-16 data was selected to be used in the solution.
 $\delta A = 28$ yards
 $\delta V = 1.3$ ft/sec

CNV - FPS-16 and VERLORT data received.
FPS-16 data was used in the solution.
 $\delta h = 63$ yards
 $\delta v = .3$ ft/sec
Two differential corrections (1 successful)

THIRD ORBIT

BDA - FPS-16 and VERLORT data received
FPS-16 data was used
 $\delta h = 98$ yards
 $\delta v = .7$ ft/sec
Two differential corrections (2 successful)

MUC - VERLORT data used in solution
 $\delta h = 1260$ yards
 $\delta v = 4$ ft/sec
Two differential corrections (2 successful)

HAW - FPS-16 and VERLORT data received
FPS-16 data used in solution
 $\delta h = 516$ yards
 $\delta v = 1.3$ ft/sec
Two differential corrections (1 successful)

19hr 23min 19sec

Manual insertion of retro rockets

Time	λ_{IP}
19hr 20min 47sec	-68.017°

CAL - FPS-16 and VERLORT reported
FPS-16 data was used in the solution
 $\delta h = 453$ yards
 $\delta v = 12$ ft/sec
Two differential corrections (1 successful)
 $\lambda = -68.92^\circ$

WHS - FPS-16 data was used in the solution
 $\delta h = 125$ yards
 $\delta v = 2$ ft/sec
Two differential corrections (2 successful)
 $\lambda = -68.80^\circ$

TEX -

VERLORT data was used in the solution

$$\delta h = 5 \text{ yards}$$

$$\delta v = .1 \text{ ft/sec}$$

Two differential corrections (1 successful)

$$\lambda = -68.80^{\circ}$$

EGL -

FPS-16 and VERLORT data received

$$\delta h = 1 \text{ yard}$$

$$\delta v = 1.8 \text{ ft/sec}$$

CNV -

FPS-16 data was used in the solution

$$\delta h = 17 \text{ yards}$$

$$\delta v = 2 \text{ ft/sec}$$

Two differential corrections (1 successful)

$$\lambda = -68.88^{\circ}$$

Both computers were in agreement throughout the mission.

BRIEF HISTORY OF THE MA-6 MISSION AS SEEN BY THE B COMPUTER

PREPARED BY

J. W. MORTON

(A) A= Semi Major axis of the orbit and is expressed in Mercury units.

E= Eccentricity.

I= Inclination Angle.

(B) The sentence referring to time to fire has the word Calculations missing and should be read in between fire and for.

(C) The times associated with emergency areas are as follows, and are expressed in Retro Sequence Times:

<u>RECOVERY AREA</u>	<u>LONG.</u>	<u>ELAPSED COMPUTED TIME</u>	<u>NOMINAL</u>
1 B	46° E	00 hrs. 17 mins. 32 secs.	00 hrs. 16 mins. 49 secs.
1 C	113° E	00 hrs. 32 mins. 04 secs.	00 hrs. 31 mins. 49 secs.
1 D	117° E	00 hrs. 50 mins. 19 secs.	00 hrs. 50 mins. 34 secs.
1 E	114° W	01 hrs. 15 mins. 42 secs.	01 hrs. 16 mins. 28 secs.
2 A	18° W	01 hrs. 36 mins. 38 secs.	01 hrs. 36 mins. 13 secs.
2 B	41° E	01 hrs. 50 mins. 00 secs.	01 hrs. 49 mins. 29 secs.
2 C	113° E	02 hrs. 06 mins. 00 secs.	02 hrs. 05 mins. 59 secs.
2 D	154° W	02 hrs. 38 mins. 29 secs.	02 hrs. 38 mins. 57 secs.
2 E	118° W	02 hrs. 48 mins. 58 secs.	02 hrs. 49 mins. 13 secs.
3 A	13° W	03 hrs. 11 mins. 25 secs.	03 hrs. 11 mins. 28 secs.
3 B	37° E	03 hrs. 22 mins. 32 secs.	03 hrs. 22 mins. 14 secs.
3 C	111° E	03 hrs. 40 mins. 17 secs.	03 hrs. 40 mins. 30 secs.
3 D	159.5° W	04 hrs. 12 mins. 32 secs.	04 hrs. 13 mins. 00 secs.
3 E	119° W	04 hrs. 22 mins. 11 secs.	04 hrs. 22 mins. 24 secs.

BRIEF HISTORY OF MA-6 EVENTS AS RECORDED ON THE B COMPUTER AT G.S.F.C.
ON FEBRUARY 20, 1962

L.O. 14hrs. 47 mins. 39 secs.

 $\gamma = -0.067^\circ$

TOWNS *155

* $V = 25727 \text{ ft/sec}$

Seco *301

* $V_{av} - V_{go} = 112.6 \text{ ft/sec}$

Caps *308

* Elapsed time since lift off.

* Based on G.E. Burroughs

20 Points used in making a GO decision.

14 hrs. 52 mins. 59 secs. Bermuda FPS - 16 begins transmission

14 hrs. 53 mins. 49 secs. Orbit phase has been entered with G.E. Burroughs as a selected source.
Apogee = 137.07; Perigee = 86.76 both apogee and perigee will be expressed in N.M.. Time of apogee - 15 h 39m 00s.

14 hrs. 54 mins. 27 secs. Time to fire for Emergency recovery area 1 B (46° E)

14 hrs. 54 mins. 32 secs. GMTRC for end of present orbit 16h 16 m 33s (56°W)

14 hrs. 54 mins. 35 secs. Canary acquisition data sent.

14 hrs. 54 mins. 38 secs. FPS - 16 Acquisition data sent. (Woomera)

14 hrs. 56mins. 23 secs. Canary acquisition data sent

14 hrs. 56 mins. 37 secs. Indian Ocean ship T/M acquisition data sent.

14 hrs. 58 mins. 4 secs. Bermuda FPS - 16 ends transmission with 44 observations.
43 observations were presented to D.C. by Edit. (FPS - 16)

14 hrs. 58 mins. 44 secs. First accepted correction at Bermuda
residuals 10^{-7}
A. = 1.033 (mercury units); E = .008; I = 32.54
Apogee = 138.15; Perigee = 86.78; time of Apogee = 15h 38m 00s

14 hrs. 59 mins. 20 secs. Emergency recovery area still 1 B (46° E).

14 hrs. 59 mins. 25 secs. GMTRC 16h 16m 27s.

14 hrs. 59 mins. 29 secs. Second correction at Bermuda rejected residuals 10^{-11}

15 hrs. 00 mins. 22 secs. Kano T/M acquisition data sent.

15 hrs. 02 mins. 16 secs. Canary begins transmission.

15 hrs. 04 mins. 53 secs. Bermuda ends transmission (Non real time) with 50 observations.
 15 hrs. 05 mins. 19 secs. Time to fire for next emergency recovery area updated to 1 C (113° E)
 15 hrs. 05 mins. 26 secs. Zanzibar T/M acquisition data sent.
 15 hrs. 05 mins. 40 secs. Muchea acquisition data sent.
 15 hrs. 05 mins. 56 secs. Canton T/M acquisition data sent.
 15 hrs. 09 mins. 29 secs. Canary ends transmission with 50 observations. 50 observations presented to D.C. by Edit.
 15 hrs. 09 mins. 47 secs. First accepted correction at Canary residuals 10^{-9}
 A=1.033; E=.008 I=32.55
 Apogee=139.01; Perigee=86.99; Time of Apogee. 15h 38m 00s.
 15 hrs. 10 mins. 25 secs. Woomera FPS - 16 acquisition data sent.
 15 hrs. 10 mins. 31 secs. Emergency recovery area still 1 C (113° E)
 15 hrs. 10 mins. 36 secs. GMTRC 16h 16m 29s.
 15 hrs. 10 mins. 41 secs. Second accepted correction at Canary residuals 10^{-11}
 A=1.033; E=.008; I=32.55
 Apogee 139.00; Perigee 87.03. Time of Apogee 15h 38m 00s.
 15 hrs. 11 mins. 14 secs. Emergency recovery area still 1 C (113° E).
 15 hrs. 11 mins. 18 secs. GMTRC 16 h 16 m 29 s .
 15 hrs. 16 mins. 18 secs. Time to fire for next emergency recovery area updated to 1 D (177° E)
 15 hrs. 16 mins. 24 secs. Indian Ocean ship T/M sent.
 15 hrs. 22 mins. 22 secs. Guaymas acquisition data sent.
 15 hrs. 22 mins. 27 secs. California acquisition data sent.
 15 hrs. 22 mins. 37 secs. White Sands acquisition data sent.
 15 hrs. 28 mins. 22 secs. Texas acquisition data sent.
 15 hrs. 28 mins. 27 secs. Muchea acquisition data sent.
 15 hrs. 28 mins. 37 secs. Canton acquisition data sent.
 15 hrs. 28 mins. 59 secs. Eglin verlort acquisition data sent.

15 hrs. 33 mins. 21 secs. Bermuda acquisition data sent.

15 hrs. 33 mins. 24 secs. Woomera " " "

15 hrs. 33 mins. 40 secs. Canaveral " " "

15 hrs. 34 mins. 16 secs. Time to fire for next emergency recovery area updated to 1 E (114° W)

15 hrs. 37 mins. 39 secs. Muchea begins transmission.

15 hrs. 38 mins. 48 secs. Apogee=138.64; Perigee=86.74; Time of Apogee 17h 07m 00s.

15 hrs. 43 mins. 22 secs. Guymas acquisition data sent.

15 hrs. 43 mins. 27 secs. California " " "

15 hrs. 43 mins. 31 secs. Woomera FPS - 16 begins transmission.

15 hrs. 43 mins. 38 secs. White Sands acquisition data sent.

15 hrs. 45 mins. 09 secs. Muchea ends transmission with 50 observations.
50 observations presented to D.C. by edit.

15 hrs. 45 mins. 21 secs. First accepted correction at Muchea residuals 10^{-10}
A=1.033; E=.007; I=32.54
Apogee 138.43; Perigee 86.7; Time of Apogee 17h 07m 00 s.

15 hrs. 45 mins. 48 secs. Time to fire for next emergency recovery area still 1 E (114° W)

15 hrs. 45 mins. 53 secs. GMTRC 16 h 16 m 29 s.

15 hrs. 46 mins. 04 secs. Second correction at Muchea rejected residuals 10^{-11} .

15 hrs. 47 mins. 22 secs. Texas acquisition data sent.

15 hrs. 47 mins. 25 secs. Canton " " "

15 hrs. 47 mins. 40 secs. Middle Atlantic Ship acquisition data sent.

15 hrs. 47 mins. 45 secs. Eglin acquisition data sent.

15 hrs. 47 mins. 58 secs. Canary Islands acquisition data sent.

15 hrs. 51 mins. 10 secs. Woomera ends transmission with 40 observations.
40 observations presented to D.C. by Edit.

15 hrs. 51 mins. 17 secs. First accepted correction at Woomera residuals 10^{-10}
A=1.033; E=.007; I=32.54
Apogee=138.39; Perigee=86.71; Time of Apogee 17 h 07 m 00 s

15 hrs. 51 mins. 49 secs. Time to fire for next emergency recovery area is still 1 E (114° W).

15 hrs. 51 mins. 54 secs. GMTRC 16 h 16 m 29 s .
 15 hrs. 52 mins. 02 secs. Second correction at Woomera rejected. residuals 10^{-11} .
 15 hrs. 52 mins. 31 secs. Bermuda acquisition data sent.
 15 hrs. 52 mins. 35 secs. Canaveral " " " .
 15 hrs. 52 mins. 43 secs. Kano acquisition data sent.
 15 hrs. 58 mins. 22 secs. Zanzibar " " " .
 15 hrs. 59 mins. 14 secs. Time to fire for next emergency recovery area is 2 A
 (18° W) this is the first emergency recovery area in the
 second orbit.
 16 hrs. 04 mins. 22 secs. Guymas acquisition data sent.
 16 hrs. 04 mins. 27 secs. California acquisition data sent.
 16 hrs. 04 mins. 37 secs. White Sands " " " .
 16 hrs. 10 mins. 12 secs. GMTRC changes from 16h 16m 29s to 17h 48m 20s. which is
 the time to fire for the end of the second orbit.
 16 hrs. 10 mins. 19 secs. Texas acquisition data sent.
 16 hrs. 10 mins. 21 secs. Eglin " " " .
 16 hrs. 10 mins. 37 secs. Middle Atlantic Ship acquisition data sent.
 16 hrs. 10 mins. 42 secs. Canary Islands acquisition data sent.
 16 hrs. 10 mins. 56 secs. Indian Ocean Ship " " " .
 16 hrs. 15 mins. 00 secs. Guymas begins transmission.
 16 hrs. 15 mins. 48 secs. FPS - 16 begins transmission. (California)
 16 hrs. 16 mins. 07 secs. White Sands begins transmission.
 16 hrs. 16 mins. 19 secs. Bermuda acquisition data sent.
 16 hrs. 16 mins. 24 secs. Canaveral acquisition data sent.
 16 hrs. 16 mins. 37 secs. Kano " " " .
 16 hrs. 17 mins. 24 secs. Texas begins transmission.

16 hrs. 19 mins. 17 secs. California FPS ends transmission with 0 observations.
(Elevation angles below 3° .)

16 hrs. 20 mins. 19 secs. Time to fire for next emergency recovery area updated
to 2 B (41° W)

16 hrs. 21 mins. 22 secs. Zanzibar acquisition data sent.

16 hrs. 21 mins. 26 secs. Eglin begins transmission (FPS - 16)

16 hrs. 21 mins. 29 secs. Guymas ends transmission with 44 observations.
44 observations presented to D.C. by Edit.

16 hrs. 21 mins. 36 secs. Canaveral begins transmission.

16 hrs. 21 mins. 40 secs. Muchea acquisition data sent.

16 hrs. 21 mins. 44 secs. White Sands ends transmission with 28 observations.
28 observations presented to D.C. by Edit.

16 hrs. 21 mins. 53 secs. First accepted correction at Guymas residuals 10^{-10} .
A=1.033; E=.008; I=32.55
Apogee = 138.39; Perigee=86.85 Time of Apogee 17h 07m 00s.

16 hrs. 22 mins. 27 secs. Time to fire for next emergency recovery area still 2 B (41° W)

16 hrs. 22 mins. 32 secs. GMTRC 17 hr 48 m 18 s.

16 hrs. 22 mins. 37 secs. Second accepted correction at Guymas residuals 10^{-11} .
A=1.033; E=.008; I=32.55
Apogee = 138.40; Perigee 86.86=Time of Apogee 17h 07m 00s

16 hrs. 23 mins. 10 secs. Time to fire for next emergency recovery area is still 2 B (41° E).

16 hrs. 23 mins. 15 secs. GMTRC 17 hr 48 m 18 s.

16 hrs. 23 mins. 22 secs. First accepted correction at White Sands residuals 10^{-10} .
A=1.033; E=.008; I=32.55
Apogee=138.4; Perigee=86.73 Time of Apogee 17h 07m 00s.

16 hrs. 23 mins. 50 secs. Time to fire for next emergency recovery area still 2 B (41° E)

16 hrs. 23 mins. 55 secs. Second correction at White Sands rejected residuals 10^{-10} .

16 hrs. 24 mins. 30 secs. Texas ends transmission with zero observations.
Zero observations presented to D.C. by Edit. D.C. by-passed.
(Zero observations still a question to be answered).

16 hrs. 25 mins. 18 secs. Eglin verlort begins transmission.

16 hrs. 25 mins. 22 secs. Woomera acquisition data sent.

16 hrs. 25 mins. 31 secs. Bermuda verlort begins transmission.

16 hrs. 25 mins. 57 secs. Bermuda FPS - 16 begins transmission.

16 hrs. 26 mins. 07 secs. Eglin ends transmissions with 38 FPS - 16 observations and 0 verlort.
38 observations presented to D.C. by edit.

16 hrs. 26 mins. 23 secs. First accepted correction at Eglin residuals 10^{-10} .
A=1.033; E=.008; I=32.54
Apogee=138.38; Perigee=86.83 Time of Apogee 17h 07m 00 s.

16 hrs. 26 mins. 51 secs. Time to fire for next emergency recovery area is still 2 B (41° E).

16 hrs. 26 mins. 55 secs. GMTRC 17 h 48 m 18 s.

16 hrs. 27 mins. 06 secs. Second accepted correction at Eglin residuals 10^{-11} .
A=1.033; E=.008; I=32.54.
Apogee=138.38; Perigee=86.83; Time of Apogee 17h 07m 00 s.

16 hrs. 27 mins. 39 secs. Time to fire for next emergency recovery area is still 2 B (41° E).

16 hrs. 27 mins. 43 secs. GMTRC 17 h 48 m 18 s.

16 hrs. 28 mins. 35 secs. Canaveral ends transmission with 35 observations.
35 observations presented to D.C. by edit.

16 hrs. 28 mins. 53 secs. First accepted correction at Canaveral residuals 10^{-10} .
A=1.033; E=.008; I=32.54.
Apogee=138.37; Perigee=86.83 time of Apogee 17h 07m 00s.

16 hrs. 29 mins. 28 secs. Time to fire for next emergency recovery area is still 2 B (41° E)

16 hrs. 29 mins. 32 secs. GMTRC 17 h 48 m 18 s.

16 hrs. 29 mins. 44 secs. Second correction at Canaveral rejected residual 10^{-10} .

16 hrs. 30 mins. 04 secs. Indian Ocean Ship acquisition data sent.

16 hrs. 32 mins. 00 secs. Bermuda ends transmission with 42 FPS - 16 observations and 8 verlort.

16 hrs. 32 mins. 02 secs. 42 observations presented to D.C. by edit. FPS - 16.

16 hrs. 32 mins. 17 secs. First accepted correction at Bermuda residuals 10^{-11} .
A=1.033; E=.008; I=32.54.
Apogee=138.36; Perigee=86.86; Time of Apogee 17h 07m 00s.

16 hrs. 32 mins. 45 secs. Time to fire for next emergency recovery area still 2 B (41° E)

16 hrs. 32 mins. 49 secs. GMTRC 17 h 48 m 18 s.

16 hrs. 32 mins. 56 secs. Second correction at Bermuda rejected residuals 10^{-11} .
 16 hrs. 34 mins. 22 secs. Kano acquisition data sent.
 16 hrs. 36 mins. 41 secs. Canary Islands begins transmission.
 16 hrs. 38 mins. 20 secs. Time to fire for next emergency recovery area up dated to
 2 C (113° E)
 16 hrs. 39 mins. 22 secs. Zanzibar acquisition data sent.
 16 hrs. 39 mins. 40 secs. Muchea " " "
 16 hrs. 39 mins. 56 secs. Canton " " "
 16 hrs. 43 mins. 38 secs. Canary Islands ends transmission with 34 observations.
 34 observations presented to D.C. by edit.
 16 hrs. 43 mins. 56 secs. First accepted correction at Canary Islands residuals 10^{-10} .
 A=1.033; E=.008; I=32.56.
 Apogee=138.36; Perigee=87.24 Time of apogee 17 h 07 m 00 s.
 16 hrs. 44 mins. 38 secs. Time to fire for next emergency recovery area is still 2 C
 (113° E)
 16 hrs. 44 mins. 43 secs. GMTRC 17h 48 m 18 s.
 16 hrs. 44 mins. 47 secs. Second corrections at Canary Island rejected residuals 10^{-10} .
 16 hrs. 45 mins. 22 secs. Hawaii acquisition data sent.
 16 hrs. 45 mins. 27 secs. Woomera " " "
 16 hrs. 50 mins. 11 secs. Time to fire for next emergency recovery area updated to
 2 D (154.7° W).
 16 hrs. 51 mins. 22 secs. Indian Ocean Ship acquisition data sent.
 16 hrs. 57 mins. 22 secs. Guymas acquisition data sent.
 16 hrs. 57 mins. 27 secs. California acquisition data sent.
 16 hrs. 57 mins. 37 secs. White Sands " " "
 17 hrs. 03 mins. 22 secs. Texas " " "
 17 hrs. 03 mins. 27 secs. Muchea " " "
 17 hrs. 03 mins. 37 secs. Canton " " "

17 hrs. 03 mins. 59 secs.	Eglin acquisition data sent.
17 hrs. 07 mins. 04 secs.	Hawaii " " "
17 hrs. 07 mins. 27 secs.	Woomera " " "
17 hrs. 07 mins. 39 secs.	Bermuda " " "
17 hrs. 07 mins. 44 secs.	Canaveral " " "
17 hrs. 07 mins. 56 secs.	Apogee=137.98; Perigee=86.77 Time of Apogee 18 h 36 m 00 s.
17 hrs. 11 mins. 09 secs.	Muchea begins transmission.
17 hrs. 16 mins. 22 secs.	California acquisition data sent.
17 hrs. 16 mins. 24 secs.	Guymas " " "
17 hrs. 16 mins. 37 secs.	White Sands " " "
17 hrs. 18 mins. 23 secs.	Woomera begins transmission.
17 hrs. 19 mins. 07 secs.	Muchea ends transmission with 50 observations. 50 observations presented to D.C. by Edit.
17 hrs. 19 mins. 21 secs.	First accepted correction at Muchea residuals 10^{-10} . A 1.033; E .007; I 32.54 Apogee 137.98; Perigee 86.75; Time of Apogee 18 h 36 m 00 s.
17 hrs. 19 mins. 53 secs.	Time to fire for next emergency recovery area is still 2 D (154.7° W)
17 hrs. 19 mins. 57 secs.	GMTRC 17 h 48 m 18 s.
17 hrs. 20 mins. 02 secs.	Second correction at Muchea rejected residuals 10^{-11} .
17 hrs. 21 mins. 22 secs.	Texas acquisition data sent.
17 hrs. 21 mins. 25 secs.	Canton " " "
17 hrs. 21 mins. 40 secs.	Middle Atlantic Ship acquisition data sent.
17 hrs. 21 mins. 45 secs.	Eglin " " "
17 hrs. 21 mins. 48 secs.	Canary Islands " " "
17 hrs. 25 mins. 09 secs.	Woomera ends transmission with 29 observations. 29 observations presented to D.C. by Edit.
17 hrs. 25 mins. 17 secs.	Time to fire for next emergency recovery area has been updated for area 2 E (118° W)

17 hrs. 25 mins. 30 secs.	First accepted correction at Woomera residuals 10^{-10} . A=1.033; E=.007; I=32.55. Apogee=138.00; Perigee=86.82 Time of Apogee 18 h 36 m 00 s.
17 hrs. 25 mins. 58 secs.	Time to fire for next emergency recovery area is still 2 E (118° W)
17 hrs. 26 mins. 03 secs.	GMTRC 17 h 48 m 18 s.
17 hrs. 26 mins. 10 secs.	Second accepted correction at Woomera residuals 10^{-11} . A=1.033; E=.007; I=32.55. Apogee 138.00; Perigee 86.84; Time of Apogee 18 h 36 m 00 s.
17 hrs. 26 mins. 43 secs.	Time to fire for next emergency recovery area is 2 E (118° W)
17 hrs. 26 mins. 48 secs.	GMTRC 17 h 48 m 18 s.
17 hrs. 27 mins. 22 secs.	Hawaii acquisition data sent.
17 hrs. 27 mins. 27 secs.	Canaveral " " "
17 hrs. 27 mins. 30 secs.	Kano " " "
17 hrs. 27 mins. 40 secs.	Bermuda " " "
17 hrs. 33 mins. 13 secs.	Time to fire next emergency recovery area has been updated to 3 A (13° W). This is the first emergency recovery area in the third orbit.
17 hrs. 38 mins. 30 secs.	Hawaii Verloort begins transmission.
17 hrs. 39 mins. 22 secs.	Guymas acquisition data sent.
17 hrs. 39 mins. 27 secs.	California " " "
17 hrs. 39 mins. 35 secs.	Hawaii FPS - 16 begins transmission.
17 hrs. 39 mins. 38 secs.	White Sands acquisition data sent.
17 hrs. 42 mins. 09 secs.	GMTRC 19 h 20 m 18 s. (This is the time to fire for the end of the third orbit.)
17 hrs. 43 mins. 23 secs.	Hawaii ends transmission with 15 FPS - 16 observations and 22 Verloort. 15 observations presented to D.C. by edit.
17 hrs. 43 mins. 41 secs.	First accepted correction at Hawaii residuals 10^{-9} . A=1.033; E=.008; I=32.57. Apogee 138.00; Perigee 86.71; Time of Apogee 18 h 36 m 00 s.
17 hrs. 44 mins. 09 secs.	Time to fire for the next emergency area is still 3 A (13° W)
17 hrs. 44 mins. 13 secs.	GMTRC 19 h 20 m 18 s.
17 hrs. 44 mins. 20 secs.	Second correction rejected at Hawaii.

17 hrs. 45 mins. 22 secs.	Texas acquisition data sent.
17 hrs. 45 mins. 24 secs.	Eglin " " " "
17 hrs. 45 mins. 27 secs.	Canary Islands acquisition data sent.
17 hrs. 45 mins. 40 secs.	Middle Atlantic Ship acquisition data sent.
17 hrs. 45 mins. 42 secs.	Indian Ocean Ship " " " "
17 hrs. 48 mins. 09 secs.	California Verloort begins transmission.
17 hrs. 48 mins. 33 secs.	California FPS - 16 begins transmission.
17 hrs. 49 mins. 32 secs.	White Sands begins transmission.
17 hrs. 50 mins. 22 secs.	Bermuda acquisition data sent.
17 hrs. 50 mins. 27 secs.	Canaveral acquisition data sent.
17 hrs. 51 mins. 11 secs.	Texas begins transmission.
17 hrs. 53 mins. 00 secs.	California ends transmission with 28 FPS - 16 and 5 Verloort. 28 observations presented to D.C. by edit.
17 hrs. 53 mins. 13 secs.	First accepted correction at California residuals 10^{-9} . A=1.033; E=.008; I=32.54. Apogee=137.92; Perigee=86.83; Time of Apogee 18 h 35 m 00 s.
17 hrs. 53 mins 41 secs.	Time to fire for next emergency recovery area is 3 A (13° W)
17 hrs. 53 mins. 46 secs.	GMTRC 19 h 20 m 16 s.
17 hrs. 53 mins. 54 secs.	Second correction at California rejected residuals 10^{-10} .
17 hrs. 54 mins. 22 secs.	Eglin FPS - 16 begins transmission.
17 hrs. 54 mins. 26secs.	Mucua acquisition data sent.
17 hrs. 54 mins. 30 secs.	Eglin Verloort begins transmission.
17 hrs. 55 mins. 51 secs.	White Sands ends transmission with 31 observations. 31 observations presented to D.C. by edit.
17 hrs. 56 mins. 07 secs.	First accepted correction at White Sands residuals 10^{-10} . A=1.033; E=.008; I=32.54. Apogee=138.01; Perigee=86.73; Time of Apogee 18h 36m 00s.
17 hrs. 56 mins. 32 secs.	Canaveral begins transmission.
17 hrs. 56 mins. 39 secs.	Time to fire for next emergency recovery area updated to 3 B (37° E)

17 hrs. 56 mins. 44 secs.	GMTRC 19 h 20 m 17 s.
17 hrs. 56 mins. 54 secs.	Second accepted correction at White Sands residuals 10^{-10} . A=1.033; E=.008; I=32.54. Apogee=138.03; Perigee=86.72; Time of Apogee 18 h 36 m 00 s.
17 hrs. 57 mins. 35 secs.	Time to fire for next emergency recovery area is still 3 B (37° E).
17 hrs. 57 mins. 39 secs.	GMTRC 19 h 20 m 17 s.
17 hrs. 58 mins. 13 secs.	Texas ends transmission (observations count garbled D.C. bypassed).
17 hrs. 58 mins. 54 secs.	Bermuda Verloort begins transmission.
17 hrs. 59 mins. 06 secs.	Bermuda FPS - 16 begins transmission.
18 hrs. 00 mins. 23 secs.	Eglin ends transmission with a garbled observations count. (D.C. bypassed)
18 hrs. 01 mins. 59 secs.	Canaveral ends transmission with 44 observations. 44 observations presented to D.C. by edit.
18 hrs. 02 mins. 16 secs.	First accepted correction at Canaveral residuals 10^{-10} . A=1.033; E=.008; I=32.54. Apogee=137.92; Perigee=86.80; Time of Apogee 18h 36 m 00 s.
18 hrs. 02 mins. 43 secs.	Time to fire for next emergency recovery area is still 3 B (37° E)
18 hrs. 02 mins. 48 secs.	GMTRC 19 h 20 m 17 s.
18 hrs. 02 mins. 56 secs.	Second correction at Canaveral rejected residuals 10^{-11} .
18 hrs. 03 mins. 26 secs.	Middle Atlantic Ship acquisition data sent. Indian Ocean acquisition data sent.
18 hrs. 05 mins. 11 secs.	Bermuda ends transmission with 49 FPS - 16 observations and 1 Verloort 49 observations are presented to D.C. by edit.
18 hrs. 05 mins. 29 secs.	First accepted correction at Bermuda residuals 10^{-10} . A=1.033; E=.008; I=32.54. Apogee=137.87; Perigee=86.88 Time of Apogee 18h 36m 00s.
18 hrs. 05 mins. 57 secs.	Time to fire for next emergency recovery area is still 3 B (37° E)
18 hrs. 06 mins. 01 secs.	GMTRC 19 h 20 m 17 s.
18 hrs. 06 mins. 08 secs.	Second accepted correction at Bermuda residuals 10^{-11} . A=1.033; E=.008; I=32.54. Apogee=137.9; Perigee=86.90 Time of Apogee 18h 36m 00s.

18 hrs. 06 mins 41 secs.	Time to fire for next emergency recovery area updated to 3 C (111° E)
18 hrs. 06 mins. 46 secs.	GMTRC 19 h 20 m 17 s.
18 hrs. 09 mins. 32 secs.	GMTRC of Capsule clocked change from 19 h 20 m 07 s, to 19 h 20 m 10 s to agree with the time to fire recommended by Goddards Computers.
18 hrs. 14 mins. 22 secs.	Muchea acquisition data sent.
18 hrs. 20 mins. 21 secs.	Hawaii " " "
18 hrs. 24 mins. 17 secs.	Time to fire for next emergency recovery area updated to 3 D (159.5° W)
18 hrs. 26 mins. 22 secs.	Indian Ocean Ship acquisition data sent.
18 hrs. 32 mins. 22 secs.	Guymas acquisition data sent.
18 hrs. 32 mins. 27 secs.	California " " "
18 hrs. 32 mins. 37 secs.	White Sands " " "
18 hrs. 34 mins. 24 secs.	Bermuda runs a tape through their transmitter with the switch on. This gives the computers a beginning of transmission.
18 hrs. 36 mins. 11 secs.	Apogee=137.54; Perigee=86.69 Time of Apogee 20 h 04 m 00 s.
18 hrs. 36 mins. 19 secs.	Texas acquisition data sent.
18 hrs. 36 mins. 24 secs.	Muchea " " "
18 hrs. 36 mins. 40 secs.	Eglin " " "
18 hrs. 41 mins. 21 secs.	Hawaii " " "
18 hrs. 41 mins. 24 secs.	Canaveral " " "
18 hrs. 42 mins. 06 secs.	Programs force an end on Bermuda transmission. Edit and D.C. are bypassed.
18 hrs. 45 mins. 01 secs.	Muchea begins transmission.
18 hrs. 50 mins. 22 secs.	Guymas acquisition data sent.
18 hrs. 50 mins. 27 secs.	California " " "
18 hrs. 50 mins. 37 secs.	White Sands " " "
18 hrs. 52 mins. 09 secs.	Muchea ends transmission with 50 observations. 50 observations presented to D.C. by edit.

18 hrs. 52 mins. 21 secs.	First accepted correction at Muchea residuals 10^{-9} . A=1.033; E=.007; I=32.55. Apogee=137.74; Perigee=86.71 Time of Apogee 20j 04m 00s.
18 hrs. 52 mins. 50 secs.	Time to fire for next emergency recovery area is still 3 D (159.5° W).
18 hrs. 52 mins. 55 secs.	GMTRC 19 h 20 m 17 s.
18 hrs. 52 mins. 59 secs.	Second accepted correction at Muchea residuals 10^{-11} . A=1.033; E=.007; I=32.55. Apogee=137.74; Perigee=86.73 Time of Apogee 20 h 04m 00s.
18 hrs. 53 mins. 39 secs.	Time to fire for next emergency recovery area is still 3 D (159.5° W)
18 hrs. 53 mins. 43 secs.	GMTRC 19 h 20 m 17 s.
18 hrs. 56 mins. 22 secs.	Texas acquisition data sent.
18 hrs. 56 mins. 30 secs.	Eglin " " "
18 hrs. 59 mins. 16 secs.	Time to fire for next emergency recovery area updated to 3 E (119° W) last emergency recovery area in the third orbit.
19 hrs. 02 mins. 22 secs.	Hawaii acquisition data sent.
19 hrs. 02 mins. 30 secs.	Canaveral " " "
19 hrs. 10 mins. 41 secs.	Hawaii Verilort begins transmission.
19 hrs. 11 mins. 42 secs.	Hawaii FPS - 16 begins transmission.
19 hrs. 14 mins. 12 secs.	GMTRC 20 h 42 m 43 s Time to fire for end of fourth orbit.
19 hrs. 14 mins. 19 secs.	Guymas acquisition data sent.
19 hrs. 14 mins. 24 secs.	California " " "
19 hrs. 14 mins. 37 secs.	White Sands " " "
19 hrs. 16 mins. 47 secs.	Hawaii ends transmission with 38 FPS - 16 observations and 12 Verilort.
19 hrs. 17 mins. 04 secs.	First accepted correction at Hawaii residuals 10^{-9} . A=1.033; E=.008; I=32.55. Apogee=137.82; Perigee=86.54; Time of Apogee 20h 04m 00s.
19 hrs. 17 mins. 31 secs.	Time to fire for next emergency recovery area is still 3 E (119° W).
19 hrs. 17 mins. 36 secs.	GMTRC 20 h 42 m 44 s.

19 hrs. 17 mins. 41 secs.	Second correction at Hawaii rejected residuals 10^{-11} .
19 hrs. 19 mins. 22 secs.	Texas acquisition data sent.
19 hrs. 19 mins. 30 secs.	Eglin " " "
19 hrs. 20 mins. 24 secs.	California Verloort begins transmission.
19 hrs. 22 mins. 09 secs.	California FPS - 16 begins transmission.
19 hrs. 23 mins. 40 secs.	White Sands begins transmission.
19 hrs. 23 mins. 49 secs.	Manual insertion of 3 retro rockets with a GMT time of 19 h 20 m 47 s (other times mentioned here have been retro sequence time which are fire times minus 30 secs.)
19 hrs. 24 mins. 08 secs.	Orbit to Reentry phase has been accomplished.
19 hrs. 24 mins. 37 secs.	Impact point Lat. 21.11 N; Long. 68.02 W.
19 hrs. 24 mins. 48 secs.	Guymas acquisition data sent.
19 hrs. 24 mins. 53 secs.	California " " "
19 hrs. 24 mins. 56 secs.	Texas " " "
19 hrs. 25 mins. 03 secs.	White Sands " " "
19 hrs. 25 mins. 08 secs.	Texas begins transmission.
19 hrs. 25 mins. 11 secs.	Eglin acquisition data sent.
19 hrs. 25 mins. 20 secs.	Canaveral acquisition data sent.
19 hrs. 26 mins. 23 secs.	California ends transmission with 17 FPS - 16 observations and Verloort. 17 observations presented to D.C. by edit.
19 hrs. 26 mins. 34 secs.	First accepted correction at California residuals 10^{-9} . Impact point. Lat. 21.53 N; Long. 68.92 W.
19 hrs. 26 mins. 53 secs.	Second correction at California rejected residuals 10^{-11} .
19 hrs. 27 mins. 22 secs.	Texas acquisition data sent.
19 hrs. 27 mins. 30 secs.	Eglin " " "
19 hrs. 27 mins. 34 secs.	Eglin FPS - 16 begins transmission.
19 hrs. 27 mins. 38 secs.	Canaveral acquisition data sent.
19 hrs. 27 mins. 42 secs.	Eglin Verloort begins transmission.

19 hrs. 29 mins. 28 secs.	White Sands ends transmission with 34 observations. 34 observations presented to D.C. by edit.
19 hrs. 30 mins. 05 secs.	First accepted correction at White Sands residuals 10^{-10} . Impact Point.
19 hrs. 30 mins. 18 secs.	Lat. 21.48° N; Long. 68.80° W.
19 hrs. 30 mins. 48 secs.	Canaveral begins transmission.
19 hrs. 30 mins. 53 secs.	Second accepted correction at White Sands residuals 10^{-11} . Impact Point.
19 hrs. 31 mins. 08 secs.	Lat. 21.48° N.; Long. 68.80° W.
19 hrs. 31 mins. 16 secs.	Texas ends transmission with 41 observations. 41 observations presented to D.C. by edit.
19 hrs. 31 mins. 49 secs.	First accepted correction at Texas residuals 10^{-10} . Impact Point.
19 hrs. 32 mins. 03 secs.	Lat. 21.48° N.; Long. 68.80° W.
19 hrs. 32 mins. 24 secs.	Canaveral acquisition data sent.
19 hrs. 32 mins. 46 secs.	Second correction at Texas rejected.
19 hrs. 33 mins. 24 secs.	Eglin ends transmission . Edit and D.C. bypassed.
19 hrs. 34 mins. 06 secs.	Canaveral ends transmission with 22 observations. 22 observations presented to D.C. by edit.
19 hrs. 34 mins. 53 secs.	First accepted correction at Canaveral residuals 10^{-9} . Impact Point.
19 hrs. 35 mins. 07 secs.	Lat. 21.52° N.; Long. 68.89° W.
19 hrs. 35 mins. 51 secs.	Second correction at Canaveral rejected residuals 10^{-10} . Final Impact Point. Lat. 21.52° N.; Long. 68.89° W.

SUMMARY OF IMPACT POINT COMPUTATIONS FOR MA-6

The following impact points were obtained during the MA-6 mission by the GSFC operational program:

CAL (FPS-16)	Lat. 21.53	Long. -68.92
WHS (FPS-16)	Lat. 21.48	Long. -68.79
TEX (FPS-16)	Lat. 21.48	Long. -68.79
EGL (FPS-16)	Lat. 21.49	Long. -68.81
CNV (FPS-16)	Lat. 21.51	Long. -68.88

Each of the above IP's are based on all of the data up to that point (i.e., the CNV solution is based on CNV, EGL, TEX, WHS and CAL data).

Post mission runs with the operational program gave the following results which are based on individual station solutions:

CAL	Lat. 21.53	Long. -68.92
WHS	Lat. 21.67	Long. -69.21
TEX	Lat. 21.50	Long. -68.83
EGL	Lat. 21.63	Long. -69.15
CNV	Lat. 21.46	Long. -68.77

ACQUISITION DATA

First Pass

BDA - 4 launch messages
CYI - Forced message and 5 min. message
ATS - None
KNO - 5 min. message
ZZB - 5 min. message
IOS - 25 min., and 5 min. messages
MUC - 25 min., and 5 min. messages
WOM - 45 min., 25 min., and 5 min. messages
CTN - 45 min., 25 min., and 5 min., messages
HAW - None
CAL - 45 min., 25 min., and 5 min. messages
GYH - 45 min., 25 min., and 5 min. messages
WHS - 45 min., 25 min., and 5 min. messages
TEX - 45 min., 25 min., and 5 min., messages
EGL - 45 min., 25 min., and 5 min., messages
CNV - 45 min., 25 min., and 5 min., messages

Second Pass - All stations were sent their 45 min., 25 min., and 5 min. messages

Third Pass

BDA - 45 min., 25 min., and 5 min. messages
CYI - None
ATS - 45 min., 25 min., and 5 min. messages
KNO - None
ZZB - None

Third Pass - continued

IOS - 45 min., 25 min., and 5 min. messages

MUC - 45 min., 25 min., and 5 min. messages

WOM - None

CTN - None

HAW - 45 min., 25 min., and 5 min. messages

CAL - 45 min., 25 min., and 5 min. messages

GYM - 45 min., 25 min., and 5 min. messages

WHS - 45 min., 25 min., and 5 min. messages

TEX - 45 min., 25 min., and 5 min. messages

EGL - 45 min., 25 min., and 5 min. messages. These messages were adjusted for blackout beginning at 19:31:34

CNV - 45 min., 25 min., and 5 min. messages. Same blackout adjustment as for EGL

Re-Entry

CAL - Late message

GYM - Borderline message

WHS - Borderline message

TEX - 1 min. message and borderline message

EGL - 3 min. message reflects beginning of B.O. as 19:31:33 1/2 min. message, blackout 19:31:24

CNV - 4 min. message, blackout 19:31:33
2 min. message, blackout 19:31:24
late message, blackout 19:31:24

BERMUDA COMPUTER PERFORMANCE IN MA-6

The Bermuda computer had at least five minutes of track from both radars on each pass on which to compute. It performed its primary function of confirming the Cape GO decision. A time history of track is given below:

First Pass

	FPS-16	VERLORT
First Acquired	14:51:56	14:51:26
Finally Lost	14:58:00	14:57:28

Second Pass

First Acquired	16:25:27	16:25:04
Finally Lost	16:30:54	16:30:52

Third Pass

First Acquired	17:58:40	17:58:30
Finally Lost	18:04:41	18:04:13

The computer performed well and no problems were noted during the operation*. The following is a time history of the computer output:

14:51:43	First point above 5 degrees
14:52:08	First output
14:52:40	SECO computed
14:52:43	CAPSEP received
14:52:54	GO decision
14:53:00	Orbital parameters transmitted to GSFC

The orbit which was determined for the first GO decision was:

V/Vr	1.009
Gamma	.06 degrees
Height	86.3 nautical miles

* NOTE - The Bermuda station lost a diesel generator at T-12 minutes. The

transfer to reserve generators caused a surge in power, which tripped the safety devices on the computer. The computer was reported red with an estimate of 5 minutes. The computer was restored to service in 2.5 minutes and it was decided to run a simulation at the T-5 minute hold. (The count was allowed to run to T-5 before a hold was called.) The results looked good and the computer was reported as green.

MA-6 ORBITAL ELEMENTS AT 15hr 05min 00sec

a = 1.0329 earth radii	semi major axis
e = .0082	eccentricity
i = 32.54 deg	inclination
ω = 78.99 deg	argument of perigee
Ω = 84.82	longitude of ascending node
m = 41.05 deg	mean anomaly
T = 88.69 min	period

QUICK LOOK ANALYSIS OF MA-6 RADAR DATA

The results of the preliminary analysis of MA-6 data is presented in tables 2 and 3. Table 2 shows the standard deviation of the MA-6 data using all of the valid observations. The validity indication is that received in the radar data. The σ values are computed from the formula $\sigma = \sqrt{\frac{\sum (O-C)^2}{n-1}}$ where n is the number of observations.

It will be noted that the σ values listed in table 3 are much improved in many cases. These values are based on the valid data above 3° elevation. The GSFC operational program uses only those valid observations above 3° because of the difficulty of correcting for refraction at these lower angles.

It should be pointed out that table 1 shows, in some instances, that only 50 observations were available. A maximum of 50 observations are used by the GSFC operational program. It has been shown that the use of more observations does not add significantly to the solution.

TABLE 1
MA-6 MISSION ORBIT TABLE

STATION	RDR	OBS VALID	NON VALID	TOTAL	h_a	h_p	USED IN D.C.	COMP	1DC	RESIDUALS 2DC	3DC	4DC
1st PASS												
BDA	16	53	3	56	138.14	86.77	43	B	-07	-11		
BDA	V	53	8	61			--					
CYI	V	63	9	72	138.99	87.02	50	B	-09	-11		
MUCHEA	V	76	17	93	138.43	86.70	50	B	-10	-11		
WOOMERA	16	40	45	85	138.39	86.71	40	B	-10	-11		
GUAYMUS	V	51	13	64	138.39	86.86	44	B	-10	-11		
WHS	16	28	28	56	138.39	86.73	28	B	-10	-10		
CORPUS CHRISTI	V	46	25	71			0					
EGLIN	16	47	9	38	138.37	86.83	38	B	-10	-11		
EGLIN	MPQ-31	18	29	47			--					
CNV	16	43	28	71	138.37	86.82	35	B	-10	-10		
2nd PASS												
BDA	16	51	13	64	138.35	86.85	42	B	-11	-11		
BDA	V	54	9	63			--					
CYI	V	48	21	69	138.35	87.23	34	B	-10	-10		
MUCHEA	V	60	1	61	137.98	86.75	50	B	-10	-11		
WOOMERA	16	29	36	65	138.00	86.83	29	B	-10	-11		
HAWAII	16	15	34	49	138.00	86.71	15	B	-09	-10		
HAWAII	V	45	4	49			--					
PT ARG	16	28	21	49	137.92	86.82	28	B	-09	-10		
PT ARG	V	27	14	41			--					
GUAYMAS	V	PASSIVE										
WHS	16	31	32	63	138.01	86.72	31	B	-10	-10		
CORPUS CHRISTI	V	58	9	67			50	A				

2nd PASS

EGLIN	16	41	1	42	138.37	86.83	38	A	-10	-11
EGLIN	V	32	9	41			--			
CNV	16	54	4	58	137.91	86.79	44	B	-10	-11
BDA	16	58	2	60	137.89	86.90	49	B	-10	-11
BDA	V	45	12	57			--			

3rd PASS

MUCHEA	V	69	3	72	137.74	86.73	50	B	-09	-11
WOOMERA	16	BEYOND 500 MILE RANGE								
HAWAII	16	38	22	60	137.82	86.54	38	B	-09	-11
HAWAII	V	52	9	61			--			
PT ARG	16	17	3	20	21.53	-68.92	17	B	-09	-11
PT ARG	V	7	33	40			--			
GUAYMAS	PASSIVE									
WHS	16	34	27	61	21.48	68.80	34	B	-10	-10
CORPUS CHRISTI	V	54	6	60	21.48	68.79	41	B	-10	-10
EGLIN	16	22	1	23	21.48	68.81	18	A	-09	-10
EGLIN	V	13	11	24						
CNV	16	27	6	33	21.52	-68.88	22	B	-09	-10

TABLE 2

STANDARD DEVIATIONS (σ) OF MA-6 DATA USING ALL OF THE VALID OBSERVATIONS

FPS-16 RADARS				VERLORT RADARS			
SITE	6 R yds	6 A mil	6 e mil	SITE	6 R yds	6 A mil	6 e mils
BDA	34.5	.34	.61	BDA	26.8	1.71	1.69
				CYI	73.2	1.44	2.04
				MUC	23.4	.94	1.47
WOM	6.96	.07	.25				
				GYM	30.3	1.02	1.82
WHS	5.98	.22	1.20				
				TEX	71.0	2.69	1.60
EGL	8.58	.24	.48	EGL	38.7	2.85	2.35
CNV	39.3	.29	.87				
BDA	14.5	.38	.66	BDA	21.8	1.08	1.19
				CYI	27.1	1.71	1.54
				MUC	39.1	1.43	1.32
WOM	2.29	.08	.14				
HAW	4.93	.31	.25	HAW	80.1	1.89	1.35
CAL	8.88	.54	.20	CAL	20.1	.70	.80
WHS	17.2	.18	.67				
				TEX	41.5	1.62	1.41
EGL	6.85	.21	.29	EGL	103.8	3.82	3.74
CNV	57.3	.32	.94				
BDA	30.6	.16	.56	BDA	63.9	1.79	1.67
				MUC	31.6	.80	1.25
HAW	8.05	.23	.56	HAW			

TABLE 3

STANDARD DEVIATIONS (σ) OF MA-6 DATA USING ONLY THE VALID OBSERVATIONS
GREATER THAN 3°

FPS-16 RADARS				VERLORT RADARS			
SITE	6R yds	6A mils	6e mils	SITE	6R yds	6A mils	6e mils
BDA	8.6	.17	.49	BDA	25.0	1.72	1.81
				CYI	19.9	1.11	1.03
				MUC	17.6	.97	.81
WOM	6.9	.08	.25				
				GYM	21.3	1.05	1.45
WHS	6.0	.23	1.20				
				TEX	65.6	2.60	1.23
EGL	8.6	.24	.48	EGL	38.7	2.85	2.35
CNV	7.0	.27	.54				
BDA	10.1	.37	.38	BDA	19.9	1.09	1.03
				CYI	9.3	1.14	.92
				MUC	23.4	1.30	.76
WOM	2.3	.08	.14				
HAW	4.9	.31	.25	HAW	22.7	1.67	1.26
CAL	8.9	.54	.21	CAL	7.0	.60	.90
WHS	17.2	.18	.67				
				TEX	20.4	1.51	.74
EGL	6.8	.21	.29	EGL	103.8	3.82	3.74
CNV	13.9	.23	.33				
BDA	9.8	.14	.36	BDA	19.9	1.78	1.38
				MUC	10.3	.75	.59
HAW	8.0	.23	.56	HAW	38.4	2.08	1.60

LIGHT/DARKNESS COMPUTATION

LAUNCH	20 FEB 62 at 14 hrs 47 min 39 sec						GSFC	
	HRS	GLENN MIN	SEC	HRS	GSFC MIN	SEC	GEODETIC LATITUDE ϕ	LONGITUDE λ
LIFTOFF	14	47	39	14	47	39		
DARKNESS	NO OBSERVATION			15	29		-20°37'4"S	67°50'19"E
LIGHT	16	01	39	16	02		-3°32'39"S	-162°2'57"W
	best obs							
DARKNESS	16	56	45	16	56		-17°47'48"S	39°41'35"E
LIGHT	17	30	47	17	30		4°45'44"S	173°30'37"E
DARKNESS	18	25	44	18	26		20°26'00"S	22°8'25"E
LIGHT	19	01	00	18	59		3°47'17"S	152°16'21"E

NOTE DARKNESS - 6° TWILIGHT CONDITION - 6° BELOW LINE OF SIGHT

RETROS 19 hrs 20 min 47 sec

DARKNESS 19 hrs 55 min

ORBIT LIFETIME 79 inertial orbits 4 days 22 hours

E. L. Duret

NASA - Manned Spacecraft Center
Langley Air Force Base, Va
March 14, 1962

MA-6
CONSOLIDATED REMOTE SITE TRIP REPORT

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WORD ONE/KEYSEARCH

D:03-14-62 MSC N:00 R MER Consolidated Remote Site Trip Report
MA-6
Mercury Atlas 6
MSC R0112A

NASA - Manned Spacecraft Center
Langley Air Force Base, Va
March 14, 1962

MA-6
REMOTE SITE TRIP REPORT

NAME ATS NUMBER 3
PERIOD COVERED BY REPORT Jan 14, 1962 TO Feb 25, 1962

1. PERSONNEL

a. Flight Controllers

J. W. Prim	CapCom
R. Cross	Systems Monitor
R. Kelly	Medical Monitor
G. F. Kelly	Medical Monitor

b. M and O Personnel

R. R. Baker	M and O Supervisor
B. H. Tuhl	Site Engineer
R. S. Baker	TM Supervisor (Acting)
H. J. Williams	TM
J. V. Kobleur	TM
R. F. Saylor	Acq Aid
C. T. Gibbons	GCC
J. W. Hilley	TTY Operator
M. W. Erb	Pt Tech
R. M. Hager	TM
H. A. O'Brien	A/G Com Tech
R. J. Ellis	Supply Supv (Mngr during msn)
*J. V. Hagan	TM Tech (returned to U.S. Feb 15)
*D. G. Binning	TM Supv (hospitalized at Monrovia Jan 18 - appendicitis)

*Not on-board for actual mission

Normal complement:	Leader (Site Engr)	)	Total of eleven RCA.
	GCC	)	ATS was staffed with
	TTY Operator	)	one extra man who will
	Eight Technicians	)	be permanently assigned
			to replace Tech. leaving
			after MA-6.

2. MISSION SUMMARY

Flight Controllers were on site at 0800Z. On SSB, Devil Fox Brass 1 (DFB 1) was weak and readable until approximately 1200Z. After DFB 1 once came in loud and clear, we had no trouble with SSB. SSB was good for the entire mission. Cape Com.Tech. was heard on HF before the mission loud and clear, but was not heard after launch. The ATS did not have contact with Friendship 7 on the first orbit. Before contact time on the second orbit, DFB 1 advised us that the capsule had a failure of the right lo thruster in yaw (failed closed). On voice contact with the astronaut, he reported that his ASCS problem was now reversed from lo left thrust in yaw to lo right thrust in yaw. This was the first indication we had of a failure in lo left thrust in yaw. He then started his 180 degree yaw maneuver. At 180 degrees he enjoyed the view and said he liked to see where he was going. At LOS he was returning to zero degrees in yaw. At LOS all systems looked good and the astronaut was cheerful and doing all tasks well. DFB 1 asked for cabin temperature and 150 VA inverter temperature. The cabin temperature was 99 degrees, inverter temperature was 190 degrees. At the end of the astronaut's transmission, he reported a bolt floating in the cabin. On the third orbit we could hear BDA and CYI on HF talking to Friendship 7. Due to CYI on HF, ATS had TM solid before voice. The astronaut reported that his instruments did not agree with the view from the window and were out as much as 30 degrees in roll, 35 degrees in yaw, and 40 degrees in pitch. He then freed his gyros and went to 0, 0, 0, and caged the gyros. After returning the gyros to normal, he went to orbit attitude and then back to ASCS. KNO called the astronaut before we lost contact and diverted his attention. The last contact we had with the capsule informed us that his attitudes did not agree again. Due to the attitude problems we were not able to get a status report. These problems were reported to DFB 1 on SSB as soon as possible.

3. SITE STATUS

a. Personnel

The personnel assigned to this station are always available since they cannot get off the ship. The personnel are competent and do their jobs well. The only man who is not completely qualified is the Com.Tech. (he cannot take code but is learning now). As a backup, there are two men who take code at 25 words plus. Five of the eleven RCA technicians will be replaced for the next mission. These men are being rotated to different assignments. Replacements are being trained now by RCA.

b. Equipment

The equipment was up on all mods for MA-6. The ship tries to carry a two-year supply of spares but when parts are not available on the ship, it is difficult to get them due to the positioning of the ship.

c. Facilities

The ATS has the standard noncommand station facilities plus SSB and a back-up TTY line to CYI.

d. Communications

The ATS has been subject to more frequent and severe propagation outages since the OSP was changed to 5 degrees north and 10 degrees west. Signal strength of RCAC is somewhat reduced, resulting in increased susceptibility to interference. Use of the ATS/CYI circuit for back-up GSC/ATS communications has helped. SSB voice with CNV is accomplished using the lower sideband of the ATS/RCAC TTY frequency and the AMR R-390 receivers with associated converters and MOPS. Back-up voice communications are with Ascension Island, AMR Station No.12.

4. DOCUMENTATION

Documentation was adequate in most respects. The network and site countdowns did not contain enough data. One of the ATS HF voice checks was omitted in the site countdown. There were too many ISI's changing the documentation.

5. SIMULATION

Generally speaking the simulations were excellent. When we were actually tracking Glenn, it was our simulation training that smoothed out the rough spots. The indications were very true to life. In questioning the telemetry people after the simulations they told us that the instructions received were clear and understandable.

It is felt that perhaps some thought might be given to having the M and O act as the pilot instead of the doctor during simulations. It was tried both ways at ATS and it ran more smoothly with the M and O acting as pilot, primarily due to the fact that he is Simulation Coordinator and is familiar with the problems.

6. PROBLEMS

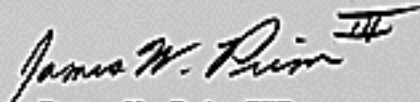
The ATS had no problems that are outstanding other than morale.

7. RECOMMENDATIONS

Something should be done to improve conditions on the ship.

8. GENERAL

The airport closest to Monrovia is Robertsfield located 48 miles from the city. Taxi service is poor and very expensive if you don't know the going price. We recommend that the American Embassy be notified when the personnel will arrive and have them meet the personnel at the airport. The Embassy is glad to help when possible. Multi-entry visas are required because you must leave the country to board the ship. Food and water are not good in Monrovia and caution should be used in eating. The only nice hotel is twenty dollars a night plus service charges. We were unable to stay there due to the price. Facilities at the other hotels are very poor. I do not recommend Monrovia. Liberia uses American currency and the prices are high. On board ship conditions are poor. The Flight Controllars room is small and uncomfortable. The bunks are too small. There are four men to a room of approximately 12 feet by 14 feet. There is not sufficient room to hang clothes. Noise from compressors and generators contribute greatly to the discomfort. The food is basic, and soon you begin eating only one meal a day. Recreation equipment is not sufficient. There is a small boat of approximately 18 feet and two 35 hp outboard motors on board ship. These are not used at all. The boat could be very useful as a launch while in port since the ship must anchor in the bay. The boat could also be used for fishing to provide recreation while the ship is drifting. This would help morale a great deal. Morale drops to a definite low when the ship must drift during holds. Communications with the United States are very poor. An amateur radio station on the ship would be well worth the effort. Some of the technicians have permits to operate such equipment. I was told that the Air Force and Pan American would not allow an amateur radio station. Liberia has no phone service to the states and mail service is very poor. Poor mail delivery was a major morale problem.


James W. Prim III
Capsule Communicator, ATS

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
February 27, 1962

MA-6

REMOTE SITE TRIP REPORT

NAME Canary Island

NUMBER 4

PERIOD COVERED BY REPORT January 15, 1962 TO February 21, 1962

1. PERSONNEL.-

(a) Control Team Personnel.-

John Llewellyn

Cap Com

Marvin Rosenbluth

Systems

J. Ward

Aeromed No. 1

R. Burwell

Aeromed No. 2

(b) M and O Personnel.-

(See attached sheet)

2. MISSION SUMMARY.-

(a) Countdown.- No major system malfunction during countdown. There was, however, a problem with the G.E.T. clock when it was counting in the minus direction, the responsible personnel tried to correct this intermittent malfunction, but the clock never worked satisfactorily. It was felt, however, since the clock performed well in the positive direction, the intermittent malfunction in the negative direction presented no serious problem.

(b) First Orbit.- The reception over Goddard Loop was very good during lift-off and the first pass briefing from the Cape. Astro was contacted on HF about 11 minutes after lift-off and reported results of control systems check to be "go." UHF contact and TIM solid came almost simultaneously. At this time, Astro began his 30-minute report, which went according to schedule. A blood pressure test was given on request (about 1 minute behind schedule) at which time Astro stated that he was repeating test. From the medical standpoint, Astro was quite cool and appeared to be confident and assured. All physiological parameters remained within normal limits and reflected no stress. Systems Monitor reported all systems normal and spacecraft was holding

in orbit attitudes. Although TIM and Astro reported high cabin temperatures, Astro decided not to adjust coolant flow, since he was comfortable. Astro made observations of Canary Islands and African Coast, and stated that the window gave a better view than periscope.

(c) Second Orbit.- Astro performed day horizon check and stated he had no problem controlling spacecraft attitude using the horizon as a control reference. Some deviations from the Flight Plan format were noted during day horizon check which was monitored at the site via voice and TIM. These deviations were considered to be Astro's choice and were not considered significant. Astro reported he could not correlate previously observed luminous particles with thruster action after being queried to do so. Spacecraft systems remained the same except for roll ignores over the station at 163902Z and 164015Z. Aeromed Report was the same as first orbit. After the pass, an examination of visicorder data showed that segment 51 (landing bag deploy) was deflected 85 percent both on high and low TIM.

(d) Third Orbit.- The third orbit went very smoothly over the CYI site. Astro gave a brief station report and stated his status was excellent. Incidentally, HF communications were loud and clear throughout entire pass and CYI had contact with "Friendship 7" for 4.5 minutes.

3. SITE STATUS.-

(a) The Canary Station is operated by Bendix Corporation personnel who provided excellent support for the MA-6 mission. All personnel appeared to be technically competent and well qualified for their various positions which gave Flight Controllers added confidence. A procedure was incorporated at this site whereby the NASA Site Manager functioned as an assistant to the Flight Control Team during simulated and real mission time. His primary function in this capacity was to monitor the Systems Monitor's Sanborn Recorder to detect any noticeable changes, and to alert the CapCom or Systems Monitor of an event light indication. The NASA Manager was very cooperative and amenable to the procedure and was a great help to the Flight Control Team.

(b) Equipment Excellent

(c) Facilities outstanding, except for the 1.5 hour drive from Las Palmas to site.

(d) Communications (See CYI PLIM.)

4. DOCUMENTATION.- (No comments)

5. SIMULATION.-

(a) Medical Monitor's comments:

(1) Lack of sufficient technical information:

a. Lack of complete description of Glenn's nodal rhythm, (not identified as upper, lower, or middle);

b. Lack of QRS and PRS intervals until just prior to launch day.

(2) Very poor simulation tapes from medical standpoint.

a. No simulated blood pressure at CYI.

b. Only two aeromed problems simulated.

(b) CapCom and systems comments:

(1) It should be recognized that the simulated Astro has limitations and hence can only provide information that he has been properly scripted for. Therefore, no one can hope for the continuity of action that is expected during an actual pass.

(2) It should be recognized that Flight Controllers/M & O interface procedures have to be adapted to simulation (i.e. TIM cannot give both high and low read-out) and after patching is done, you cannot confirm events as in actual mission.

6. PROBLEMS.- The Goddard Conference Loop furnished very poor service except on launch day, and it was never possible to monitor voice debriefing during Test 5460.

7. RECOMMENDATIONS.-

(a) Perhaps 3 or 4 simulations prior to launch are valuable for procedures and site readiness, but excessive simulations engendered by delays tend to diminish significance of actual mission.

(b) Recommend deployment of Flight Controllers be established to preclude unnecessary time on site in case of delays.


John Llewellyn
Flight Controller

December 11, 1961

GRAND CANARY ISLAND

MERCURY TRACKING AND GROUND INSTRUMENTATION STATION

M & O SUPERVISOR	R. Vaughan
ADM. ASST.	G. Burch
LOGISTIC	W. Balling
FACILITIES MAINT. SUPV.	L. Stewart
SITE ENGR.	C. Andrasek
SITE ENGR.	M. Hampton
MAINT. CLERK*	G. Delgado
PLANT FOREMAN	G. Brown
CAPSULE COMM. SUPV.	B. Farrow
ACQ. AID SUPV.	J. McCarthy
TIM. SUPV.	R. Buster
DATA PROC. ENGR.	H. Guss
VERLORT SUPV.	L. Prestwood
GROUND COMM. SUPV.	H. Knight

Indigenous Personnel

NASA - Manned Spacecraft Center
Langley Air Force Base, Va
March 1, 1962

MA-6
REMOTE SITE TRIP REPORT

NAME KNO MISSION NUMBER 5
PERIOD COVERED BY REPORT Jan 15, 1962 TO Feb 27, 1962

1. PERSONNEL.

a. Flight Controllers

1.	E. L. Duret	Capsule Communicator
2.	C. W. Rumbaugh	Systems Monitor
3.	C. Kratochvil	Medical Monitor
4.	V. Marshbanks	Medical Monitor

b. M and O Team Personnel

1.	A. E. Smith	NASA Station Director
2.	J. C. White	M and O Supervisor
3.	R. Anthony	Site Engineer
4.	E. Giroux	Admin, Assistant
5.	C. Johnson	Site Engineer
6.	E. Drake	TIM Supervisor
7.	J. MacDonald	TIM Technician
8.	R. Adcock	TIM Technician
9.	J. C. Clouse	TIM
10.	J. Erch	Acq Aid Supervisor
11.	D. Schurr	Acq Aid Technician
12.	T. R. Moran	CTC/Test Equipment
13.	R. Montgomery	Timing/Telemetry
14.	B. Carr	Gr Comm Coordinator
15.	W. D. Gardner	Teletype M and O Technician
16.	S. Sullens	Teletype M and O Technician
17.	C. Youngblood	Transmitters
18.	W. Keating	PBX/Intercom/Receivers
19.	G. G. Saltzman	Logistics

2. MISSION SUMMARY. The mission was fairly uneventful as far as this station was concerned. It was more satisfactory than simulations because air-ground from the Cape was picked up at launch, and the site was better informed before acquisition than it had been on any simulation.

The astronaut was not very interested in retrosequence time for area one Charlie and it is suggested that, in future, the astronaut be allowed to initiate a request for these times, if he wishes, rather than have the CapCom initiate the information when the astronaut might be attempting to catch up on his flight plan.

There was some confusion regarding reporting on Segment 51. This is understandable because of the serious implications attending a deployed landing bag. However, it brings up the point that remote sites, under the present communications rules, cannot initiate a special message except during pass time. The landing bag episode shows that it is perfectly possible for a site to discover an important piece of information shortly after L.O.S. In view of the FIO traffic now appearing on the network, it would seem advisable to allow remote sites to initiate specials to MCC at any time, a suitable amount of discretion being used.

3. SITE STATUS.

a. Personnel. Performance of the M and O personnel during simulations and the actual mission was entirely satisfactory, and the Flight Controllers had complete confidence in their support. A difficulty arose on one T-3 mission when a misunderstanding arose on the time M and O personnel should begin their working day. They arrived on site at T-3 and they were using the buses which usually carried Flight Controllers to the site at T-3 also. The result was that the Flight Controllers were late on site, the CapCom arriving more or less on time, since the M and O picked him up in his own automobile. Other Flight Controllers, staying at another hotel, were an hour and a half or so late. Site personnel and the CapCom cooperated to get the confidence summary out on time. The whole situation was complicated by the fact that telephone communications are next to useless in Nigeria. This is discussed later.

b. Equipment. OK

c. Facilities. There were transport problems here. See Item 6.

d. Communications. Telephones are not common in Kano. Few of the site personnel possess them in their homes, and although the hotels are theoretically equipped with a few telephones, in practice they do not really constitute a communications system. The reason for this is the limited ability of the native staff to understand English when spoken on the phone, and also the fact that there are only one or two phones per block. Residents of the block are inclined to answer a phone only when they themselves are expecting a call, and if a member of the hotel staff answers, he usually gives up rather easily in trying to find the party being called.

4. DOCUMENTATION. No problems.

5. SIMULATION. The simulation team at the Cape did a good job adapting the original scripts to new situations under difficult conditions. It seems to be next to impossible to simulate a complete mission consistently when an astronaut is involved, due to the communications problem Cape Sim faces in updating the situation. Sim messages sometimes arrived too late to do much good at KNO. Nevertheless, the simulations are extremely useful and their purpose is accomplished even if complete consistency is not always obtained.

A detailed study of the times taken for sim messages to reach the addressee would probably prove useful in showing Cape Sim what can reasonably be expected from remote sites during a simulation. This information is contained in PLIM part III, sent after each simulation to GSC.

6. PROBLEMS.

a. Telephone Communications. These have been referred to already.

b. Transportation. It is recommended that at least one Flight Controller obtain a Nigerian drivers license (cost 1 Pound). A day would be saved in obtaining this if he had three passport type photos of himself with him on arrival. He will need his U. S. drivers license, but there is no test. Having at least one license will enable the Flight Controller team to become independent of site transportation, which is difficult to organize due to the telephone problem.

c. PAO Messages. On at least two missions now, the teletype network has been used for PAO or PIO messages without a previous briefing being given to personnel using the network operationally. This has on occasion resulted in some confusion at remote sites and delays in receiving operational messages. It is true that no critical delays have occurred so far. Some delays have occurred, however, and there seems to be a possibility in the future that one might turn out to be critical.

7. RECOMMENDATIONS.

a. Site personnel mentioned that they appreciated the news items which came in via teletype while Flight Controllers are deployed, and asked if they could be made a permanent feature continuing after Flight Controllers depart. Mr Alvin Smith, the NASA Site Manager, mentioned that this might not be possible, due to established press policies. However, this should be implemented if at all possible. If all remote sites were completely staffed by NASA personnel, it is felt that a way would be found to broadcast news regularly on teletype. For the purposes of any particular project, all contractors should be treated as part of the same team in this respect.

b. From the observations made at KNO, it is possible to state categorically that newspaper reporters would be better informed on the mission by listening to the Voice of America or the BBC than by coming out to the site and receiving the handouts supplied by the PIO. It is, of course, very important to keep the public informed, but it is difficult to see what these PAO messages accomplished at KNO. If they are absolutely necessary, it is recommended that all sites be able to initiate specials at any time to keep what could be important operational information from being delayed. Flight Controllers should be briefed to use discretion on the use of priority messages so as not to interfere with PAO messages unnecessarily.

c. Trip reports should be made available to site managers at all stations. This should enable them to make improvements where needed. They could, at their discretion, release them to M and O teams, or to the M and O supervisor.

d. An effort should be made to have visas made valid for longer than a "short visit" at KNO. This is interpreted to be two weeks by Nigerian officials (a fortnight, to be exact), and no amount of discussion would persuade them to make the visit valid for a month or so when the Flight Controllers first arrived. The Nigerian government appears very friendly and would probably grant a longer visa initially if the situation is made clear. Renewing the visa periodically is a great inconvenience. On one occasion, our passports and documents were mislaid for a day or so.


Eugene L. Duret
Flight Controller


C. W. Rumbaugh
Flight Controller

MA-6

Remote Site Trip Report

Name - Zanzibar

Number 6

Period covered by report 11 Jan. '62 to 22 Feb. '62

1. Personnel

a. Flight Control personnel

John H. Langford - Cap. Com.
Richard P. Rembert - Systems
Frank Flood - Aeromed
Sam Fox III - Aeromed

b. M and O Personnel

Roger Locke - M and O Supervisor and Acting NASA Site Manager
Bob McPhail - Site Engineer
John Lentini - Site Engineer
Ross Pickes - Administrative Assistant
Jim Ulrich - TM Supervisor
Harry Zajdel - TM Disc. Operator
Joe Miller - TM Recorder Operator
Bill Wilson - TM Receiver Operator
Irv Dosick - A/G Comm. Supervisor
John Adams - Comm Tech Console Operator
Tom Boyette - Transmitter Van Technician
Dean McLaskey - Ground Comm Cord.
Joe Weldon - Teletype Op/Maint
Bill Brown - Teletype Op/Maint
Vance Caudle - PEX/ Intercom Technician
Clay Hartson - Acq Aid Supervisor
Chuck Jay - Acq Aid Technician
Chuck Braumiller - Timing and Test Equip.
Bob Mason - Logistic Supervisor

2. Mission Summary -

Flight Controllers manned console positions at T-3 hours. The site status message was released by cap com and the repeat of the EST's started. All systems were green and remained green for entire mission. The confidence summary was sent at T-2:20 and the results broadcast by MCC indicated no major errors.

During the first pass the astro. followed the flight plan and transmitted the 30 min. report. The detailed capsule status section of the 30 min. report agreed with TM readouts and indicated that the capsule systems were performing satisfactory. The medical section of the report indicated that the astro. was in excellent condition and had adapted to the weightless state very well. One observation made during this time was the cloud cover over Eastern Africa.

During the second pass the astro. status was still good but the capsule control system was not performing satisfactory. The ASCS low yaw thrusters were not operating properly. The astro. reported that the low right yaw thruster was not working and the low left yaw thruster had started working again. This was the reverse of previous station reports. Also, near the end of the pass, intermittent pitch IG was observed on TM. All other control systems were o.k. The astro. was controlling on ASCS with manual as back-up. At one point during the pass the capsule drifted too far out of attitude and Glenn stopped what he was doing and brought the capsule back to orbit attitude using manual control. The inverter temperatures had started to rise again and were reading near 200°F. The 30 min. report was only partially given due to the control problem. The observations made during this pass were that he could see lightning from a thunder storm located south of Zanzibar and that he could look directly at the sun as it went down without it hurting his eyes by shading them with his eyebrow. Also, he noted that the horizon on either side of the sun was a bright blue. After the pass the tape was played and it was observed that there was 85 percent signal on landing bag deploy event. All other systems were o.k.

On the third pass HF contact was established for about 1 min. and the astro. reported his status as good with the control systems same as previous pass.

The capsule UHF voice was excellent from horizon to horizon. The HF from CYI, KNO, IOS, and MUC was good. The capsule HF on the third orbit was readable during contact and again when it was over IOS.

The mission was highly successful and had a big impact on the people of Zanzibar. They followed the mission on Voice of America.

3. Site Status

a. Personnel

A number of problems occurred at the site involving site personnel which reflected poor judgement on the part of the individuals and placing the M and O supervisor in an awkward position in the dual roll of Bendix supervisor and acting NASA site manager. It is recommended that every effort be made to appoint a permanent resident site manager at Zanzibar to protect the interests of NASA and international relations.

Several new personnel arrived on site just prior to the MA-6 mission. All personnel proved to be technically competent.

b. Equipment

The equipment is maintained at a high level. The spare level is adequate. A large inventory is necessary at Zanzibar as local purchase of spares is not possible.

c. Facilities

In general, station facilities are in good repair. A definite heat problem exists at the transmitter site. This is being investigated by the M and O crew and a report is being forwarded through channels.

d. Communications - no problems.

4. Documentation

a. Mission rules - no problems

b. Data plan

The site copies of the data plan were shipped by surface mail by mistake and did not arrive until 15 Feb., causing a shortage until then. An effort should be made to ensure delivery at the earliest possible date for MS-7.

c. SOP's - no problems

d. ISI's

F/C felt that there was an excessive number of ISI's this mission. There was one case of a meter calibration being changed twice by two ISI's the same day and the final change was back to the original. An effort should be made to review the ISI's before they are broadcast.

5. Simulations

Zanzibar participated in all simulations fully. The F/C felt that these simulations were the best to date. However, an attempt should be made to refrain from re-using the astro. scripts with minor changes as the astro. simulator would confuse the two and tend to put things into the script that were not there.

One problem encountered on the last simulation was improper adjustment of the pulse coder. The final simulation, mission No. 4, orbit one had a bad segment on the tape. This resulted in the decom dropping a pulse causing all the following segments to be misplaced by one. On investigation it was found that the TM crew was not following the BST's to the letter resulting in improper adjustment of the pulse coder.

6 and 7. Problems and recommendations have been discussed above.

8. General

Zanzibar is still needing a reperferabor for the teletype room for relaying messages to IOS. Under the present system the TTY operator must retype all IOS traffic.

9. Medical problems

All medical comments will be submitted later.

John H. Langford
John H. Langford
Cap Com

Richard Rembert
Richard Rembert
Systems

dpb

NASA - Manned Spacecraft Center
Langley Air Force Base, Va.
March 9, 1962

MA-6
REMOTE SITE TRIP REPORT

NAME IOS NO. 7
(Site) (Site)

PERIOD COVERED BY REPORT 1/10/62 TO 2/20/62

1. Personnel

A. Flight Controllers

David A. Beckman	Capsule Communicator
Harold W. Hopp	Systems Monitor
Frank H. Austin, Jr.	Medical Monitor
Victor G. Benson	Medical Monitor

B. M and O Personnel

Jack M. White	Ship Operations Manager (PAA)
Fred W. Perkins	Instrumentation Leader
Cecil B. Davis*	Acquisition Aid
Vance Heeg**	Communications Technician
Larry Hazelbaker	Point-to-Point Receiving System Operator
J. O. Ingham	Communications Center Operator
J. K. Marshall	Decommutator Operator
Klaus L. Frenzel	Telemetry Supervisor
F. Gorski**	Timing
B. F. Brown	Telemetry Recorder Operator
V. L. Lyons**	Communications Center Operator and Teletype Technician
R. J. Neville*	Point-to-Point Transmitter Operator
C. E. Calaway	Display Consoles and Sanborn Recorders

Note: * Transferring after arrival at drydock, Durban, South Africa
** Returning to the United States for leave/training for 6 weeks
after MA-6.

2. Mission Summary.

The Indian Ocean Ship supported two countdowns for Test 5460, the first resulting in a scrub due to Cape weather. The Acquisition Aid was in a red status at that time, and it was planned to track the capsule manually. Single side-band voice was excellent with direct communications to Mercury Control Center.

The second attempt of Test 5460 was on February 20, 1962 after several delays due to weather. IOS status was green at this time. Local weather included moderate seas and 20-knot winds, preventing the inflation and release of the 30,000-foot altitude balloon flares, and mortar flares were used instead.

Prelaunch HF checks indicated only the adjacent sites of Zanzibar and Muchea could be heard. SSB communication checks showed conditions variable with both short- and long-term fading between IOS and Pretoria, Ascension, and Antigua. Cape transmissions were not heard.

Prior to Pass 1 over IOS, ZZB but not the capsule came through on HF with fair signal strength. UHF signal strength rose very rapidly as the capsule appeared at the horizon, and remained loud and clear until telemetry LOS. TLM decom could not lock on until approximately 3 minutes after acquisition due to interference from HF point-to-point transmitters which had not yet been turned off. These transmitters are kept on the air until the contact message is transmitted. It was noted that TLM HI remained strong enough for decom lock some 30 to 45 seconds after LOS of TLM LO. Plans were made to switch to HI link on Passes 2 and 3 after TLM LO LOS, but the phenomenon did not recur. Astro was reporting visual sightings with no major problems indicated. Astro could not observe IOS flare.

Pass 2 showed no major changes from Pass 1. Astro reported his difficulty with ASCS, and his attention to this problem prevented much opportunity for visual sightings.

During Pass 3, Astro reported his continuing problem with the ASCS and decided to use fly-by-wire to conserve fuel. Voice contact was maintained on HF throughout the Pass with good results. No flare was released due to complete cloud cover.

3. Site Status.-

A. Personnel

Due to the nature of station location, M and O personnel generally spend no more than 12 months duty aboard ship. Replacements are either new hires or technicians transferred from Atlantic Missile Range assignments; in either case, they have had no previous experience with Project Mercury equipment or procedures. At the completion of MA-6, two technicians are to be replaced, and three others are to return to the United States for training and/or vacation of approximately 6 weeks duration. It is felt that the level of experience and competence of this group is not as high as those at previous Mercury sites I have visited.

A complete change of Suwanee Steamship Company ship operations personnel will take place on April 1, 1962.

B. Equipment

(1) Storage: no problems. Equipment must be carefully stored to prevent damage due to ship vibration and/or pitch and roll motion. Equipment placed on shelves should be securely anchored by clamps or strong straps.

(2) Maintenance - The fact that during mission periods no commercial supply or repair services are available and the ship is entirely "on its own" caused some nightmareish problems during MA-6. The rewinding of a burned-out Acquisition Aid motor for which no spare was available gave a small group of technicians considerable late-evening entertainment, particularly when it burned out again about 2 minutes after being placed back in service. Other maintenance problems were minor in nature and were repaired by on-site personnel.

(3) Modification - The System Monitor's Sanborn Recorder was loaded aboard ship just prior to sailing on January 15, 1962, and was installed while the ship was underway. Modification to the Systems Monitor Console was still in work at time of sailing and completed approximately 2 days later. No modification problems were reported by the Instrumentation Leader.

(4) Spares - Sufficient spares are always a problem aboard an isolated station such as the Indian Ocean Ship, particularly with larger nonstandard parts such as motors and amplidydes, but generally speaking, there are adequate spares aboard for normal requirements. The ship has an advantage in also carrying AMR equipment which, in case of emergency, could possibly be used for substitution or replacement.

C. Site Facilities

Site facilities appeared adequate to properly support the mission. Locally instituted modifications reported by other sites, such as TLM condition lights and HF/UHF receiver indicator lights on the Flight Control Console, have not been made at this station, but should be. A direct communications link between the Capsule Systems Monitor and TLM Decom Operator was installed and proved to be very useful.

D. Communications

Teletype communications were good in general throughout the premission and mission periods.

It is this writer's opinion, unofficially concurred with by the ship personnel, that the teletype receiving equipment (manufactured by Technical Material Corporation) is below the minimum quality needed for high reliability reception. The greatest problems are concerned with long-term stability and susceptibility to ship motion and vibration. This situation becomes especially critical when poor communications conditions exist during mission time, requiring an operators constant attention to the receiving equipment, leaving only one man to cut, transmit, and receive all mission traffic.

The site has been requesting authorization to operate on a lower frequency at night to improve TTY receiving conditions; however, this authorization has not yet been effective.

The Zanzibar backup circuit was used with the best results to date; however, no ROTR (automatic retransmit) equipment presently is installed at Zanzibar, requiring all messages to be recut by hand before relaying. Goddard reports this equipment is now on priority order and is due to be in operation before MA-7.

Single side-band voice was available and was used to exchange updated information with Mercury Control Center. Results varied from excellent to almost unusable dependent upon ionospheric conditions. A memorandum is being prepared to suggest improvements in the use of this network.

4. Documentation.

A. Mission Rules - Satisfactory in content, suggest reorganization to separate rules into main sections concerning Prelaunch, Launch, and Orbit and Reentry - these to be subdivided into systems areas. This will make fewer pages for those personnel not directly concerned with Prelaunch and Launch activities (e.g. Remote Sites).

B. Data Plan - Satisfactory

C. Procedures - Satisfactory

5. Simulations.-

The IOS supported seven simulations in preparation for MA-6. No major problems with either equipment or personnel were encountered except for the AcqAid. The AcqAid was red due to azimuth and elevation motor malfunctions which were repaired before Test 5460. Single side-band voice to MCC was used during the last simulation (B5) with fair results; ionospheric conditions prevented direct contact with the Cape. It is felt that simulations B3 and B4 were not as useful as could be desired, since they were essentially reruns of previous simulations.

In addition, it is my opinion that the number of simulations was excessive and actually began to produce negative results, attitudes, and morale among flight controllers and technicians. It is for this reason I had decided that if an additional (eighth) simulation were scheduled, I would have requested that the IOS be released from support of that simulation.

6. Problems.-

- (a) Personnel - competence and turnover, paragraph 3.A.
- (b) Teletype receiving equipment, paragraph 3.D
- (c) Teletype night frequency authorization, paragraph 3.D.
- (d) Single side-band voice, paragraph 3.D.
- (e) Excessive simulations, paragraph 5.
- (f) Travel and miscellaneous, paragraph 9.

7. Recommendations.-

- (a) Equipment storage - paragraph 3.B.(1)
- (b) Installation of Flight Control aids, paragraph 3.C.
- (c) Mission Rules - paragraph 4.A.
- (d) Flight Control and Ship Personnel Morale and well-being - paragraph 8.

8. Accommodations.-

Living conditions for the Flight Control team remains unchanged from previous missions. Sleeping quarters are crowded with four people occupying a space the same size as the technician's quarters which only have two per room. An adjoining bathroom, however, is quite nice, although small.

During the MA-6 mission, more personnel were aboard than there was room for, so one technician was required to sleep in the Officer's Recreation Room. Recreation and entertainment onboard is essentially nil, and consists of half a dozen movies (vintage early 1940's - fresh ones delivered about every 2 to 3 months), reading material, listening to short-wave radio, and sunbathing. Needless to say, humor and morale wears rather thin after a few weeks, especially with rough weather and simulations thrown in for good measure.

Additional staterooms are scheduled to be added during the time the IOS is in drydock, but most of this additional space is already assigned to a team of three meteorologists who will be a permanent addition to the ship. Two of these staterooms will be made from the Officer's Recreation Room, thereby eliminating the motion-picture projection area.

I hereby recommend the following items:

(a) Ship accommodations situation should be thoroughly studied in the light of future anticipated space and personnel requirements, and appropriate action taken to insure rectification of deficiencies.

(b) Better and more recent movies should be supplied in greater quantity to the ship.

(c) Operation of an Amateur Radio Station should be authorized onboard ship during Mercury operations. This would be a great help in the morale problem as unofficial messages and telephone patches to stateside relatives could be easily arranged.

9. Travel and Miscellaneous.-

(a) An incorrect and incomplete message was sent to the Ship Operations Manager announcing our arrival, so that no one was at the airport to help us (we finally made it to a hotel for the night) and the SOM made an unnecessary trip to the airport the next day to meet us. It is important that the arrival message specify names, flight number, and date of arrival.

(b) A single GERA (Government Excess Baggage Authorization) was written for the return trip. The exact routing and carriers are noted on the form, with the result that if any change in either routing or

carriers is required, the entire form is invalid, requiring writing GTR's for each segment of the return trip. I strongly suggest that separate OEDA's be written for each portion of the trip to reduce the amount of TR-writing required to the minimum. The simplest solution, of course, would be the issue of an Air Travel Credit Card to each CapCom.

(c) Rival airline carriers are often very reluctant to sign over a ticket to their competitors; however, persistence and stubbornness produced consistent successful results.

(d) It is recommended that approximately \$50 in cash be brought to the ship by each Flight Controller to pay for meals and items purchased from the "slop chest". Be forewarned, however, that some troubles have been experienced in the past with counterfeit \$20 bills on Mauritius, and so the trouble given the ship personnel by the local banks forces them to prefer payment in bills of other denominations.

(e) Request for return reservations by ship radiogram before arriving at Mauritius was very helpful and is definitely recommended.

(f) Air Mail from the United States requires 5 to 7 days. The ship's address is as follows:

U.S.A.F. Coastal Sentry
c/o Blyth Bros. Ltd.
Port Louis, Mauritius

(g) Suggestions to newcomers to Mauritius is expertly covered in the Medical Monitor's Section of this report.



David A. Beckman
Capsule Communicator

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
March 12, 1962

MA-6
REMOTE SITE TRIP REPORT

NAME MUCHEA NUMBER 8
PERIOD COVERED BY REPORT January 14, 1962 TO February 23, 1962

1. PERSONNEL.-

a. Flight Control Team

1. Maj. L. G. Cooper, Jr.	Capsule Communicator
2. Mr. Stanley Faber	Capsule Communicator
3. Mr. Lloyd White	Systems Monitor
4. Capt. Ed Beckman, USN, MC	Medical Monitor
5. Wg. Comdr. W. Bishop, RAAF, MC	Medical Monitor

b. M and O Team Personnel

1. Mr. Lewis Wainwright	M and O Supervisor
2. Mr. S. M. (Gus) Pugh	Site Engineer
3. Mr. S. A. (Sol) Mathews	TLM Supervisor
4. Mr. Gerry O'Connor	Communications Technician
5. Mr. Bob Norton	Intercom Technician

2. MISSION SUMMARY.- The countdown and pre-acquisition times were uneventful, except for a minor failure in a TLM recorder which delayed the confidence check. This was repaired and the station was all green at 1137Z.

a. First Pass.- UHF voice contact and TLM contact was made at the same time. Astronaut could be heard earlier on HF, but was garbled. All RF signals were strong and clear. The A/G net was switched onto the Goddard loop by the CapCom (2) for almost the entire period of control. This procedure worked considerably better than in the simulations. There was sufficient time on this pass for the standard report, for several observations, for a Z and R calibration, and for an additional blood pressure recording.

The Astronaut and all systems were excellent. Astronaut reported all control systems operating correctly.

Handover to Woomera worked smoothly and with no conflict in communications.

b. Second Pass.- UHF voice and TLM contact were made at the same time. A/G was placed on Goddard loop for entire pass.

There were several discrepancies in this pass. The Astronaut reported all three attitudes were indicating erratically in correlation with visual alignment, with roll off the most at 20°. Inverter temperatures were indicating quite high. However, when the results of the R calibration on this pass were applied (4 and 8 PFS), the temperatures corrected to within mission rule limits. (It is believed that MCC should have teletyped this information to all sites and prevented several sites having some anxious moments.) A 10 PFS change in suit temperature also showed up on R calibration, but was not critical to mission control.

The FBW control system was inoperative on the low torque yaw right thruster, but was operative on both high torque yaw thrusters.

As requested by MCC, Segment 51 (Landing Bag Deploy) was monitored this pass. A zero signal was present. Astronaut was queried and replied that landing bag deploy switch was "Off" and no noise from heat shield was heard.

Astronaut reported he was satisfied with both the FBW and the Manual Proportional systems. He reported he was feeling fine and had no ill effects from weightlessness.

An apparent lack of roll slaving was noted, with the TLM readouts indicating the same 20° error reported by the Astronaut. It is believed that this may have been a failure of the roll ignore TLM, with the problem being corrected on the sunny side. The 8 minute on - 22 minute off operation of the slaving system may have confused the Astronaut's evaluation of the fault.

A further fault not noted immediately in the scanner operation was that both horizon scanners demonstrated sudden increases (10 PFS) several times during the second and third passes. These shifts lasted for an average time of 15 seconds.

Attitude variations of -28° to +46° in pitch, -25° to +10° in roll, and -32° to +14° in yaw did not appear to affect the received signal in either voice, TLM, or radar.

Handover to Woomera worked very smoothly.

c. Third Pass.- Astronaut was unreadable on HF and was advised to switch to UHF. UHF contact was made approximately 2 minutes after TLM was solid. Astronaut gave standard 30-minute report. The same discrepancies were present in FBW and in attitude indications. Astronaut informed Mueha he would line up spacecraft visually after daylight and reassess the gyro problem. If gyros and ASCS appeared okay, he would fire retros on ASCS and use Manual Proportional as a backup.

Due to shortened contact, the command voice check, reminder to drain bladder, and further observations were not accomplished. Z and R calibrations were sent and showed the same shifts as on the second pass.

Handover to Woomera was quite satisfactory.

d. General Comments.- The new switch at the CapCom console to switch the A/G loop onto the Goddard loop works very well.

HF was not as good as it has been previously. IOS was never received, and the spacecraft could not be clearly received although ZZB and BDA were received loud and clear. Apparently, the Astronaut was reading the HF from this site. The spacecraft HF check at T+1:04 was recorded, but the Flight Controllers at the site were involved in preparing the post-pass message and missed the reply at T+1:06.

3. SITE STATUS.- Excellent. The recorder trouble was of a minor nature and would not have affected the mission support. The performance of the radar team was exceptional. The TLM personnel demonstrated initiative and ability in their setup to monitor any desired segment of either the high or low link.

4. DOCUMENTATION.- Still very weighty, but satisfactory.

5. SIMULATION.- There were too many simulations. The entire team appeared to grow a little stale with the many repeats. The use of site personnel as Astronaut voice leaves much to be desired. The second Aeromed works somewhat better but if he is required on shots, he should be in on simulations (as a medic) as well. The best passes on simulations were those in which the simulated Astronaut was briefed just before the pass on what he was to be asked.

The multitude of minor items discussed and debated at MCC on debriefings should be reduced. Even with debriefing tonic, the hours began to drag at the remote sites as the sun began to rise over the horizon. Most of these items could be debated and decided upon and word sent out to the sites by teletype on the debriefing messages.

6. PROBLEMS.- HF radio was not satisfactory from a westerly direction.

There is a problem with either the Astronaut or the sites knowing whether horizon scanners are working correctly or not. This might be solved if either continual slaving were employed, or if the Astronaut were given an indication of when slaving is occurring.

The systems monitor's Sanborne recorder pen #4 failed after the first pass. Data was repeated on his panel, so readings were not lost.

The preparation and evaluation of readings for the summary message took almost the entire attention of the systems monitor. The suggested revision in procedures of reporting only consumables is thought to have considerable merit.

There is insufficient room at the console for five people. Either the monitor team should be streamlined in number, or the console desks enlarged in both width and length.

The present size of the team is necessary where problems are occurring in flight, unless procedures are revised. The second CapCom might be eliminated if the systems monitor can report the requested data directly to MCC, and his summary data items be reduced or rescheduled.

Pre-plotted radar plotboard paper need not be sent to this site. The site team can plot a satisfactory nominal in 10 to 15 seconds.

TLH emergency event lights should be red instead of green.

7. RECOMMENDATIONS.-

a. A Volkswagon is cheaper and better transport than other vehicles. Avis appears to be the best "hiring agency" in Perth.

b. A flat or house, either on the beach or in town, will cost considerably less than a hotel. (5 to 10 pounds a week versus 14 pounds a week per person in a hotel). This will also be more convenient as to eating, rather than having to conform to established meal hours at a hotel.

c. Bring plenty of automatic (U.S. Govt. type) pencils, both in regular lead and in China-marking grease.

d. Use the Air Flash telephone from Woomera. It works well and gives a private net.

e. MCC should keep remote site controllers better informed about scrubs, holds, recycles, and schedules after shots.

f. Plan on spending several days in Australia after a shot. This is due to airline schedules, etc. Get booked well in advance on the airline (preferably TAA and not ANA), even though you have to call and reschedule several times.

g. Standard 30-minute voice report over Muchea is too detailed. It is believed that this time could be more effectively used for observations, etc.

8. GENERAL.-

a. Travel.- There are three airlines serving Australia from the United States: Qantas, TAI (Air France), and Pan American. Both Qantas and TAI provided excellent equipment and service.

Within the continent of Australia, there are two internal airlines. Ansett-Ana and TAA. Ansett-Ana is an independent airline and TAA is Government-run. TAA, in general, provided far better equipment and service.

b. Accommodations.-

1. Sydney.- Australia, Rex Carlton, near air terminals. Rex and Cleveron Hilton, at Kings Cross, the fun section of town.

2. Adelaide.- Australia hotel has best accommodations and is the most modern. Motels are available.

3. Perth.-

Flats.- (Furnished)

Cottesloe Beach - 5 to 8 pounds per week (1 to 2 Bedrooms)

Scarborough Beach - 5 to 8 pounds per week

Houses.- (Furnished - Beach house type)

Scarborough Beach - 5 to 10 pounds per week (3 to 4 Bedrooms)

Contact: Stan Mitchell, agent for L. J. Werne Estate Agency at Scarborough Beach, Western Australia.

Hotels.- (There are many hotels in outskirts of Perth; Here are two of the better ones:)

Morley Park - In northern area of Perth. Nearest to site. Most modern, has private baths in rooms. Owned by a Mr. Lancaster and managed by John Wettler. Cost: 2 pounds per person per day (this includes breakfast).

Charles - In northwest Perth - on Charles Street. Excellent food, good rooms, but very few with private baths. Price is same as Morley Park.

Hotels. - There are two modern American-type motels on the south side of Perth. These run about the same as the hotels previously mentioned. The drive is longer to the site, but you are near the Great Eastern and Great Northern Highways which make travel fairly fast.

Restaurants. -

Charles Hotel - Has late liquor license, but must be in dining room prior to 2200 hours to stay late. Located on Charles Street.

Ocean Beach Hotel (OBH) - Same as above. Located at Cottesloe Beach.

Heidelberg - Same as above. Downtown.

Corazinis - Same as above. Downtown on Hays Street.

Hr. Ernst (BYOB) - Food, combo, late hours. Located on Swan River.

Sea Crest (BYOB) - Food, combo, late hours. Located at Cottesloe Beach.

European Club (BYOB) - Food, combo, late hours. Located Downtown.

Canterbury Club - Dances on Wednesday, Friday and Saturday.

Embassy Club (BYOB) - Late hour club.

El Calib - Late hour club.

Lui's - Late hour club.

Luigi's - Restaurant with liquor licence.

Alberto's (BYOB) - Restaurant

4. Money. - American currency can be cashed in any bank. American Express Checks can be cashed at almost any hotel and at all banks. The Morley Park will also cash personal checks.


L. Gordon Cooper, Jr.
Capsule Communicator

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
February 27, 1962

MA-6
REMOTE SITE TRIP REPORT

NAME Woomera NUMBER M9

PERIOD COVERED BY REPORT January 11, 1962 TO February 25, 1962

1. PERSONNEL.-

(a) Control Team Personnel -

Mr. F. Volpe	Capsule Communicator
Mr. W. Wafford	Systems Monitor
Dr. E. Overholt	Aeromedical Monitor
Dr. J. Lane	Aeromedical Monitor

(b) M and O Team Personnel -

Mr. W. Kaye	M and O Supervisor/Site Manager
Mr. K. Morgan	Assistant M and O Supervisor
Mr. W. Kempees	T/M Supervisor
Mr. D. Grabner	Communications Engineer
Mr. D. Woolhead	GCC
Mr. F. Rowe	Communications Technician

2. MISSION SUMMARY.- During the mission, the only instrumentation problem this site had was a magnecorder failure at lift-off, and by T + 45 minutes the magnecorder was operating again. During the first pass, Woomera acquired telemetry and had solid telemetry for 8 minutes. The radar track was valid for 4 minutes. Voice communications were excellent. All spacecraft systems were green, and with the exception of the high inverter and cabin temperatures, all systems were normal. The Astronaut conducted his 30-minute check and the results of all the physiologic tests were good.

Again, during the second pass no problems were encountered in acquiring the spacecraft. Telemetry was solid for 8 minutes and radar track was valid for 3 minutes. Spacecraft control problems prevented the Astronaut from completing the 30-minute check. Astronaut reported the ASCS was not holding orbit attitude in yaw, and that the FEW mode was not functioning in the right low yaw thruster. The inverter temperatures had increased to the 200° level. The Astronaut status was good.

During the third orbit, we were pleasantly surprised by the amount of time we had solid telemetry. We acquired the spacecraft with little difficulty, and had solid telemetry for 3 minutes. UHF communications were good. Radar tracking was not valid, but we were expecting this, due to low elevation angles. During this pass, the Astronaut status and spacecraft status had not changed from previous pass.

On all three passes, all biological read-outs were good except the respiration rate read-out; this was due to the Astronaut talking which affected the respiration rate sensor.

3. SITE STATUS.-

(a) Personnel - No problems in this area. Personnel are both available and competent. They are also retainable.

(b) Equipment - With the exception of the Acquisition Aid equipment, there were no major problems with the site equipment, either during the simulations or the mission. The Acquisition Aid had been a continual problem during our visit. Two days prior to the first attempt of Test 5460, the Acquisition Aid was exhibiting VCO problems and was not repaired until 2 hours prior to launch.

All modifications, with the exception of EI-29, up to EI-41, have been made. The M and O Supervisor has requested that the Acquisition Aid Sanborn Recorder be on site prior to the next mission. No problems with space parts. They are flowing in regularly with no outstanding shortages.

(c) Facilities - No comments. Detailed description of facilities can be found in MA-4 and MA-5 trip reports. There have been no changes since these reports.

(d) Communications - There had been a marked improvement in the conference loop communications, although the Guaymas, California, and Texas sites were still reading below other sites during inertial simulation. It is still necessary for the CapCom to wear two head sets to offset the background noise, and for this reason, the CapCom would like to see a double ear headset on site for the next mission. Communications during the mission were excellent. There had been little HF interference and UHF was always loud and clear.

4. DOCUMENTATION.- Inground documentation is quite good, but is still too much. The document OR 1905 is still to be used. Other than the Flight Plan, Data Plan, SEDR 109, FCH 1 and FCH 2, all other documentation should be mailed to the site.

Revisions are still the biggest concern to the flight control team. The CapCom feels that the procedure which is used to update the MG 102-15 is both useless and time wasting. Teletype communications revisions are no different than any other site revisions and so they should be incorporated by site personnel. Then any changes in TTY communication which affect flight controllers can be reported to FC team by the GCC.

The SDR 109 manual is very useful and handy. It is the only document available which attempts to outline all normal, emergency, and trouble-shooting procedures. Thus, all attempts should be made to issue a valid copy for the next mission.

5. SIMULATIONS.-- Simulations for Test 5460 were very good and much to the surprise of the flight control team, the simulated Astronaut performed quite well. This was due to the excellent scripting by the simulation team. In a few isolated cases, the scripts were in conflict with flight control observations, but these were minor and resulted in very little confusion. Obviously, on occasions when failures in one or more systems occurred, detailed interrogation of the "Astronaut" by the CapCom lead to very little added information and this of course was not realistic.

It is unanimously felt that there were indeed too many simulations. One or at most two simulators are sufficient. It is also felt that additional simulations which are scheduled when a launch date has slipped a few days are both unnecessary and useless.

6. RECOMMENDATIONS.--

- (a) A maximum of two simulations for the next flight
- (b) A double eared headset be on site for the CapCom use

7. GENERAL.-- Refer to MA-4 and MA-5 trip reports. There are no changes.

8. MEDICAL.-- No additional comments. Refer to MA-4 and MA-5 trip reports.


Frank A. Volpe
Flight Controller

FAV:ajp

1. WCC should have reported the range regarding the report per design
of the situation and a more limited network-wide approach.

2. The information WCC of the desirability of releasing the A/R to
Godard within the M and S back to the CapCom's console. This
modification was entered at all voice after during the two-week hold
and on-site procedures regarding this function were greatly simplified.

3. The constant CapCom is not related with the operation of the
"Comm Voice In - Comm Voice Out" push switch on the CapCom console. At
present the way was associated with the indicator lamp in this function
does not have a wide enough range to permit both "Comm Voice Out" to be
illuminated when command voice is locked out and "Comm Voice In" to be
illuminated when command voice is unlocked in. This same problem has
been noted at other command sites in the past and is believed to be a
design fault.

4. Recommendations

a. Long-term knowledge of the stabilization and control system should
be enhanced by a reference lecture series for all flight controllers.
Technology regarding this system should be standardized and clearly
defined.

b. WCC should make efforts to provide the range with as much briefing
and trouble-shooting data as is practicable in order to maximize the
amount of knowledge available at any point in the range at any given time.

c. The problem stated in paragraph 3d regarding the indicator lamp
associated with the command voice lockout push switch on the CapCom console
should be corrected. This was spelled out in CAL Query No. 3 for MA-6
and in Call of Godard replied stating that Godard would investigate the
problem subsequent to MA-6.

d. Recommend that two-way communication between WCC and the Astro
unit via a remote site and the Godard loop be attempted for MA-7 with
at least one of the remote sites.

e. Recommend transfer of emergency locked or locked sites to cut to
a station of our.

5. General

a. Security - Still insufficient at times but much of the original
information has been obtained through the efforts of Colonel J. A. Meadows,
Chief, Security Office, and Mr. P. T. Smith, Assistant Security
Officer. Flight controllers going to CAL must have WCC phone in their

MA-6

REMOTE SITE TRIP REPORT

NAME CTN

NUMBER 11

PERIOD COVERED BY REPORT January 16, 1962 TO February 20, 1962

1. Personnel

a. Control Team Personnel

R. Higgins	Capsule Communicator
W. Huber	Systems Monitor
F. Holmstrom	Medical Monitor
D. Graveline	Medical Monitor

b. M and O Team Personnel

J. Rathner	PMR Rep.
D. Stewart	M and O
J. Weaver	Comm. Tech.
G. Smithberg	GCC
J. Burris	TTY
A. Lindsey	TLM Sup.
J. Wilson	Acq. Aid
R. Epperly	Recorders
J. Moore	RCVRS

2. Mission Summary

During the countdown all site systems checked out OK. At T-1 hour the secondary T/M discriminator failed and was out throughout the entire mission. All other ground systems performed well.

On the first pass the first two capsule transmissions to the Cap Com were not received. We realized at the time that the astronaut should be transmitting and made a quick check of headsets and checked to see if anyone else heard the capsule. At this time the last few words of the second capsule transmission came in loud and clear and the A/G voice was very good for the rest of the pass. The first two capsule transmissions were recorded on the onboard tape and I have no sensible explanation for why they were not received on the ground. All capsule systems looked good from both capsule and ground.

On the second pass no new capsule problems occurred over CTN. However, we had very sketchy information on the control problem and no explanation of the reason for concern about the landing bag. The astronaut had caged and realigned gyros just prior to contact and was not yet sure if they were holding. I failed to recommend that he try the free

position if they drifted off again. I feel it would have been very desirable to be able to return to ASCS if necessary and back it up with manual due to the low fuel consumption of the ASCS and because it would give the astronaut more time for checklists, etc. This would have been possible if astronaut had kept attitudes from becoming large enough to activate orientation mode. We did not recommend this as a possibility because we had so little information on the problem. I did not query the astronaut on the performance of the control system because the trouble had initially occurred nearly an orbit before our acquisition and I was sure this would have been duplication of effort. The facts actually were not known and the time would have been well spent if we had tried to discover the problem.

Non-voice sites can contribute to the mission only if they receive briefing messages which say what is known and what is not known. Otherwise they must start from the beginning which results in several sites doing the same thing and no one really getting all the desired information. From our standpoint at CTN, if there was a failure in this quite successful mission, it was the failure of the Cape to keep us advised of what was going on.

3. Site Status

a. Personnel.- Personnel turnover is a problem at CTN. Due to the location this will continue to be a problem and Flight Controllers should be prepared to double-check areas where new personnel are working.

b. Equipment.- Secondary de-com failed at T-1 hour. No other equipment problems occurred. The site has no spare meters (systems monitor panel type).

c. Facilities.- Quarters were provided in PMR Quonset huts and were quite adequate. If these are available for future Flight Controllers there will be no quarters problem. We tried to get a promise that the same quarters would be available to future Flight Controllers but met with no success. Meals are provided at an FAA dining hall and are adequate. However, Flight Controllers are charged for meals on a daily basis (\$4.25 per day whether meals are eaten or not) and an additional \$1.25 is charged for a night lunch consisting of four slices of bread. If this situation can't be cleared up I suggest that Flight Controllers who want to lose weight be sent to CTN. I would not pay the price until I was close to starvation and I'm sure other Flight Controllers have felt the same.

d. Communications.- TTY was good most of the time but mission briefing received on TTY was poor.

4. Documentation

a. Mission Rules.- OK

b. Data Plan.- OK

c. SOP's.- See section 2 (Mission Summary), paragraph 4 on briefing of sites.

5. Simulation

Simulations were OK in general. Our simulation tape was noisy and one section was poorly annotated, which resulted in the wrong section being run for one simulation. I feel that there were more simulations than necessary. Two simulations prior to a scheduled shot should be adequate. If additional capsule operation or a particular emergency situation needs to be considered it could be done with a five-minute script instead of a ten-hour simulation.

6. Problems

(Reference section 3 (Site Status), paragraph (b)). The secondary discriminator has been giving trouble since MA-4. These problems may not be related, but MA-7 Flight Controllers should check this item when they arrive on site to make sure the problem has been corrected.

7. Recommendations

a. Deployment of recovery forces and Flight Controllers.- MA-4, MA-5, and MA-6 have all had lengthy delays after deployment of forces because of delays in preparation of capsule and booster. These delays have caused great work loss, personal inconvenience, and have been very costly. A logical solution to at least a part of this problem would seem to be to deploy forces only after more complete launch preparation has been made. This might result in the launch vehicle being prepared a few days ahead of the range, but in view of possible gains this would seem to be a small sacrifice.

b. If Flight Controllers are going to be required to be on site for extended periods with no specific job to do, I suggest a well-lighted area be provided on site for Flight Controller activity. The three sites which I have been to (HAW, IOS, CTN) have no area which is sufficiently well-lighted for continuous reading.

8. Travel

Commercial transportation to CTN is almost a thing of the past. With prior notice one PAA flight per week will make a stop going South for \$600 in passengers or cargo. No Northbound flights are available at all and the Southbound flight would never stop to pick up passengers because of communications difficulties and because they don't want to stop. This makes it imperative to have access to all military flights to and from CTN. During long holds transportation could be arranged to and from Hawaii with the recovery forces. However, I was unable to find the person with authority to guarantee a return to CTN from HAW on the past mission, and it appears that this would be most easily accomplished from recovery headquarters at the Cape. The recovery forces were completely unprepared to help Flight Controllers because they were unaware

of the problems. (For example, they didn't have extra parachutes and could not provide transportation from CTN to HAW.) If the same personnel are involved, this situation will be improved for MA-7; however, it should be backed up and airplane schedules controlled from this end. In addition, there are many "Deep Freeze" flights through CTN at the present time. These are Air Force airplanes controlled by the Navy and approval to carry passengers must come from Australia. This approval would be difficult to get for a military person and impossible for a civilian. It would be helpful if we could get a blanket OK to use these flights. No trouble will be encountered in boarding any military flight leaving CTN if room is available. The problem occurs in getting schedule information and getting through the MATS terminal in HAW.

Rodney F. Higgins

Rodney F. Higgins
Capsule Communicator
CTN

MA - 6
REMOTE SITE TRIP REPORT

NAME HAW NUMBER 12
PERIOD COVERED BY REPORT January 15, 1962 TO February 20, 1962

1. PERSONNEL.

a. Control Team

Robert E. Ermull
Charles Olasky
John Longan
Col. Robert Moser
Col. William Hall

CapCom
Assistant CapCom
Systems Monitor
Surgeon
Surgeon

b. M and O Personnel

R. Hill
N. Crisp
J. R. Hunsinger
D. G. Williamson
C. W. Hughes
T. E. Heys
F. E. Goad
R. F. Salazar

M and O
Active Systems Engr
T/M Supervisor
GCC
ComTech
Command Tech
FPS-16
Verlort

2. MISSION SUMMARY.

a. Countdown. FC team on site at T-4; no significant problems encountered during count.

b. First Orbit. No contact - HF interference.

c. Second Orbit. There were no significant changes from previous reports on performance of capsule systems. Inverters continued to read approximately 190° and 200°. The astronaut reported he had positioned the capsule in a zero-zero-zero attitude and caged the gyros; however, the gyros continued to drift particularly in roll. Capsule attitudes were compared with ground readouts and were in reasonably close agreement. The astro could not determine drift rate.

We had patched Seg. 51 into the X-Y plotter and during the pass this signal came on at 82 percent level - time of occurrence was 173836Z (GET of 025057), approximately two minutes after acquisition.

d. Third Orbit. Immediately after contact requested astro to place landing bag switch in auto position and see if the landing bag light would illuminate, indicating the landing bag had deployed. Astro complied and no light resulted indicating the bag had not deployed. We then requested the astro to change the clock by one second to 043237 which he did. Astro then reported the ASCS to be operating reasonably satisfactory with some drift in yaw axis. Inverter temperatures were up to 225 and 212 degrees and this information was passed on to the astronaut. The astro was in the middle of a GET time hack when voice was lost. The time check was not completed successfully and we advised CAL that the astro would probably want this upon contact.

3. SITE STATUS.

a. Personnel. As reported after MA-5, Hawaii is staffed with a group of competent and enthusiastic people. The MA-6 operation merely confirms this previous report. Cooperation with the Flight Control team could not have been better. In addition to providing the best possible support to the Flight Control team, the M and O personnel continually demonstrate their ability and enthusiasm by pointing out technical problems and procedures which effect the entire network. An excellent example is the problem they uncovered in the command system, that of command initiation by power loss, and which required a modification around the network.

b. Equipment. This is an area which I leave to the M and O people, but I am not aware of any particular problems at Hawaii.

c. Facilities. I consider the intercom modification for the second CapCom unsatisfactory; will make a specific recommendation at a later date.

d. Communications. During the MA-6 count and mission we experienced interference on TM, radar, and HF. These were reported and will not be discussed further here, except to state that none of the interferences produced significant effects on the mission with the exception of the HF interference. This prevented any contact with the capsule on the first orbit.

4. DOCUMENTATION.

- a. Mission Rules - Good.
- b. Data Plan - still many changes.
- c. SOP's - no comment.

5. SIMULATION. Simulations in general were very good even with the problems created by "amateur astronauts." Simulation debriefings were too long - suggest one spokesman and outline of pertinent points of simulation.
6. PROBLEMS. As noted.
7. RECOMMENDATIONS. As noted.
8. GENERAL. Prince Kuhio Apartments are by far the best accommodations for Flight Control team.
9. MEDICAL. Medical report is attached as enclosure 1.


Robert E. Ernull
Hawaii, CapCom

Enc:
Aero-Med Report

MA-6 TRIP REPORT

AERO-MEDICAL(HAW)

1. Travel and Locale. No change over previous reports; refer to MA-4 and MA-5 trip reports for any new personnel coming to the site. All conditions are ideal at this station.

2. Operations Trip Report.

a. The new site M and O, Robert Hill, is a fine, intelligent, cooperative person, and an adequate replacement for Joseph Aldridge. The other site personnel remain the same.

b. In my opinion the permanent site personnel are superior. Their performance during simulations and the actual mission left nothing to be desired. Colonel Hall and I were significantly impressed by their eagerness to help, professional excellence and remarkable speed in getting things done. We cannot be high enough in our praise of the team at Kokee.

c. The Flight Control team also worked with maximum harmony and efficiency. CapCom Robert Ermull is the best we have seen; John Longan is an excellent, studious Systems man; and Charles Olasky was a fine supplement to the CapCom.

3. Site Status.

a. Excellent as in previous missions.

b. Mod status - changes were made rapidly and competently, usually prior to T-3. There were no apparent deficiencies.

4. Drills.

a. All sims went smoothly; any existing difficulties were quickly detected and corrected.

b. Network performance was impressively good. MUC and WOM summaries were arriving regularly before acquisition and in ample time to plot trends. It is evident from careful review of sum messages that variations in readings are probably due to standardization and dial interpretation differences between sites.

5. Mission Operations.

a. No specific comment from Hawaii. Communications were excellent during both passes. Data was transmitted quickly to and from the capsule.

Aeromedical evaluation was made quickly and "go" information was transmitted to CapCom by simple hand sign. During the pass the Aero-medical monitors shut off the Goddard loop and flight control loop to enable concentration on Astronaut voice (to assess alertness, speech characteristics). If the Flight Director gets a request from the Cape for Astro status he points to a sign on the Aero-med console which reads "ASTRO STATUS" and also pushes the Goddard loop talk button on the Aero-med console. This system has worked well during simulations and permits uncluttered listening to Astro voice which remains the most valuable parameter of physiologic evaluation.

6. Procedures. No comment.

7. Countdown.

a. Site - no comment.

b. Network - no comment.

8. Documentation. No comment.

9. Miscellaneous. No comment.

10. Recommendations.

a. Procedural recommendations described under 5 - "Mission Operations."

b. Suggest eliminating the "Heart Rate" read out on console; it is not very reliable and can be done quickly from the EKG direct writer.

c. Suggest designing rulers (as we have done) to count respiratory rate and also heart rate by measuring interval between single beats. This is more rapid and permits many observations to be made in a shorter time interval.

d. For all practical purposes there is no need for two aero-medical monitors at each site. As far as Colonel Hall and I are concerned there is insufficient work for two physicians. I suspect the same applies to CapComs.

e. The flow of pre-launch physiologic data from the Cape was adequate except for the description of the arrhythmias which made it difficult to determine whether it was indeed nodal or ventricular in origin. We also received conflicting information on QRS duration and aberration which was confusing.

f. The exercise test done over our station (Post-20/1942Z) caused HR rise from 80 to 100 which subsided to 80 within 30 seconds. It is probable that the exercise test is inadequate to cause any true stress in the well-conditioned Astronaut and should be revised for future missions.

for- *RE Enull*
Robert Moser
Medical Monitor

NASA - Manned Spacecraft Center
Langley Air Force Base, Virginia
March 14, 1962

MA-6
REMOTE SITE TRIP REPORT

NAME CALIFORNIA NUMBER 13
PERIOD COVERED BY REPORT January 12, 1962 TO February 24, 1962

1. PERSONNEL.

a. Flight Controllers

1. Astronaut Walter Schirra	Capsule Communicator
2. Arnold Aldrich	Assistant Capsule Communicator
3. Ted White	Systems Monitor
4. Maj. Harry Bratt (USAF)	Surgeon
5. Capt. Carl Pruett (USN)	Surgeon

b. M and O Team Personnel

1. Al Ross	M and O Supervisor
2. William Johnson	Site Engineer
3. Lloyd Slagle	Telemetry and Timing Group Leader
4. Robert Stoll	Telemetry and Timing Technician
5. Donald Cross	Telemetry and Timing Technician
6. Wallace Byrd	Telemetry and Timing Technician
7. Melvin Kearns	Telemetry and Timing Technician
8. George Meyers	Verlort Group Leader
9. Eugene Mayer	Verlort Technician
10. Kenneth Whitney	Verlort Technician
11. Robert Krabbenhoft	FPS-16 Group Leader
12. Jeremiah Dolis	FPS-16 Technician
13. Joseph Yokobosky	FPS-16 Technician
14. Vaughn Yeterian	FPS-16 Technician
15. Wilfred Jankowski	Acq. Aid and Data Trans. Group Leader
16. Thomas Owen	Acq. Aid and Data Trans. Technician

17. Warren Whitely	Acq. Aid and Data Trans. Technician
18. Richard Keup	Acq. Aid and Data Trans. Technician
19. Donald Wilson	Plotboard Operator
20. Robert Sorrells	Data Corrector Technician
21. Frank Przeslicke	Comm. and Command Control Group Leader
22. Clarence Overholt	Command Technician
23. Robert Larson	Communications Technician
24. Robert Ellis	Transmitters Technician
25. Ernani Silva	Receivers Technician
26. Edward Berry	Intercom and PBX
27. Richard McCown	Ground Communications Coordinator
28. Lawrence Gonzales	TTY Operator
29. Ralph Smith	Message Controller

2. MISSION SUMMARY.

a. Prelaunch. - Flight controllers arrived on site at T-3 hours. Operations at CAL progressed very smoothly throughout the countdown. Information received from the Cape regarding mission progress was greatly enhanced by NBC-TV during this period.

b. CAL Pass No. 1. - CAL experienced good UHF voice, telemetry, and FPS-16 track. Astro status was "one" and all capsule systems looked good except for some yaw attitude drift in the ASCS control mode. The 150 v-amp inverter temperature was up to 200° F.

c. CAL Pass No. 2. - Good UHF voice, telemetry, and C- and S-band radar track. Astro status was excellent. A check of capsule versus ground attitude readouts showed good correlation although this had not been the case over HAW. The Astronaut reported a small drift in yaw reference. The 150 v-amp inverter temperature rose from 215° F to 220° F during the pass. Segment 51 (impact bag deploy signal) read 85 percent throughout the pass.

d. CAL Pass No. 3. - Good UHF voice and telemetry. C- and S-band radar track were good after retrofire; however, the plotboard display was erratic and did not give useful information regarding retrofire. Retrosequence was initiated by the clock at the correct GMTRC. Retro-rockets fired on time with a d-c current reading of HHH accompanying retrorocket 1 firing. The integrating accelerometer indicated a ΔV of 400 fps. The Astronaut used manual control to backup the automatic system during retrofire. Some yaw deviation occurred but the capsule stayed within limits. During retrofire, the auto fuel went from

40 percent to 25 percent and the retrorocket temperature to HHH. Astro status was "one", however, the flight controllers did not understand his reason for believing his capsule clock to be off at CAL contact. This was of some concern to the Astronaut, however, a time "hack" showed that the capsule clock was right on.

3. SITE STATUS.-

a. Personnel.- All personnel participating in MA-6 at the CAL site displayed a high degree of competence in their respective job areas.

b. Equipment.- No major problems in this area were experienced. Several spares were required that were not in the site inventory, however, local suppliers are readily available in the California area.

c. Facilities.- Excellent. Through efforts of site people, FMR made bunks available to flight controllers if needed during work hours. During both launch counts, the lunch counter was opened during off hours for convenience of Mercury people in the building.

d. Communications.- Excellent

4. DOCUMENTATION.-

a. Mission Rules.- Good. Pleased that so few changes were necessary in spite of long hold periods.

b. Data Plan.- Good, much improved over MA-5.

c. SOP's.- Satisfactory.

d. ISI's.- Too many, too many corrections to ISI's. Recommend clearer definition of what should, what should not, go into these messages. Also, separation of flight control ISI traffic and M and O ISI traffic would be desirable.

5. SIMULATION.- Simulations were excellent in view of the limitations (tape only planned for three missions, different, unskilled Astronaut at each site). It was felt that too many simulations were run, however, and "simulation morale" was at a low level towards the end.

6. PROBLEMS.-

a. Poor reporting procedures were used by remote sites, MCC, and the Astronaut regarding the capsule control problems during the second orbit. The system status was not fully defined until the Astronaut contacted MCC at the end of the orbit.

b. MCC should have updated the range regarding the impact bag deploy signal problem. This would have permitted more complete on-site evaluation of the situation and a more unified network-wide approach.

c. CAL informed MCC of the desirability of relocating the A/G to Goddard switch from the M and O desk to the CapCom's console. This modification was effected at all voice sites during the two-week hold and on-site procedures regarding this function were greatly simplified.

d. The assistant CapCom is not satisfied with the operation of the "Comm Voice In - Comm Voice Out" push switch on the CapCom console. At present the mag amp associated with the indicator lamps in this function does not have a wide enough swing to permit both "Comm Voice Out" to be illuminated when command voice is locked out and "Comm Voice In" to be illuminated when command voice is switched in. This same problem has been noted at other command sites in the past and is believed to be a design fault.

7. RECOMMENDATIONS.-

a. Rangewide knowledge of the stabilization and control system should be enhanced by a refresher lecture series for all flight controllers. Terminology regarding this system should be standardized and clearly defined.

b. MCC should make efforts to provide the range with as much briefing and trouble-analysis data as is practicable in order to maximize the amount of knowledge available at any point in the range at any given time.

c. The problem stated in paragraph 6d regarding the indicator lamps associated with the command voice lockout push switch on the CapCom console should be corrected. This was spelled out in CAL Query No. 3 for MA-6 and D. Call of Goddard replied stating that Goddard would investigate the problem subsequent to MA-6.

d. Recommend that two-way communications between MCC and the Astronaut via a remote site and the Goddard loop be attempted for MA-7 with at least one of the remote sites.

e. Recommend number of surgeons located at remote sites be cut to a maximum of one.

8. GENERAL.-

a. Security.- Still inconvenient at times but much of the original confusion has been eliminated through the efforts of LComdr J. A. Meadows, Point Arguello Security Officer, and Mr. P. T. Smith, Assistant Security Officer. Flight Controllers going to CAL must have MSC phone in their

security. They should then contact Mr. Jim Boring, NASA FMR Rep at the CAL site, giving him their names and exact time(s) of arrival. Upon arrival at Arguello, badges, "after hours" passes, and a car pass should be at the gate. If these are not at the gate, they must be obtained from the Security Office (or the Officer of the Day, if after hours) before going up to the site.

b. Social.-

1. Good Places to Eat.-

- | | |
|---------------------|---|
| The Lobster House | - Excellent seafood cafeteria; on the waterfront in Santa Barbara |
| Sirloin Steak House | - Inexpensive steak lunch; $\frac{1}{2}$ mile south of Santa Maria business district on Route 101 |
| Rich's Rancho | - Steak dinner; $\frac{1}{2}$ mile north of Santa Maria on Route 101 |
| The Hitching Post | - Excellent steak dinner; halfway between Santa Maria and Vandenburg AFB. |
| Andersen's | - Pea soup restaurant and wine cellar; 20 miles south of Santa Maria on Route 101 |
| Chinese Restaurant | - In downtown Santa Maria |

2. Entertainment.-

On Friday and Saturday nights, when can't make Los Angeles or Santa Barbara, try the following spots in Santa Maria:

- | | |
|------------------|--|
| Rich's Rancho | - $\frac{1}{2}$ mile north of Santa Maria business district |
| Vandenburg Hotel | - Just north of Hunter's Inn |
| The Ranch House | - One mile south of Hunter's Inn on opposite side of street. |

- SORRY, THAT'S ALL -

3. Places of Interest in Area.-

- La Purisima Mission - Restored as State Park, located in Lompoc
- Solvang - Danish community. Go south of Santa Maria and turn left for two miles
- Pismo Beach - Clams, beach buggies, swimming

4. Motels.-

- Hunter's Inn - Preferred. Located 1500 S. Broadway, Santa Maria

Also; The Vandenburg Hotel and Rich's Rancho appear first-rate.

Walter W. Schirra
Walter Schirra
Capsule Communicator

Arnold F. Aldrich
F/ Arnold F. Aldrich
Assistant Capsule Communicator

Ted White
Ted White
Systems Monitor

NASA - Manned Spacecraft Center
Langley AFB, Virginia
February 26, 1962

MA-6

REMOTE SITE TRIP REPORT

NAME GYM

NUMBER 14

PERIOD COVERED BY REPORT February 10, 1962 to February 21, 1962

1. PERSONNEL

a. Control Team

Paul Brumburg - Assist. CapCom

Dr. Tom Davis - Sir John

Dan Hunter - Systems

Tom Moore - CapCom

Dr. Tux Turner - Assist. Sir John

b. M and O Team (same as MA-5)

2. MISSION SUMMARY

HF contact was established on the first orbit at 1608Z. We had solid TM at 1614Z. We therefore had contact 6 minutes prior to acquisition for determining a "go" for the second orbit. Astro was requested to switch to UHF at acquisition. Telemetry and voice contact were excellent for all three orbits.

Just prior to LOS on the first orbit, astro reported that the left low yaw thruster on ASCS was not operating properly for he drifted about 20 degrees to the right.

A 30-percent signal of scope retract was observed at GYM. Astro was made aware of it, and he reported scope A-OK. This was a ground failure.

Prior to acquisition, astro reported seeing thousands of small particles at sunrise that were drifting along with him. He estimated that some of the particles had a velocity of about 3 feet per second with respect to the capsule.

3. SITE STATUS

No change (excellent).

Volume control setup - very good.

Flight controller - M and O - Site Manager relationship was excellent.

4. DOCUMENTATION

A-OK

5. SIMULATION

Simulations in general were very good. As mentioned before, I still think it would be advisable to have at least one single orbit simulation to prepare GYM. Along with a one-orbit mission maybe we could run a contingency reentry over Australia.

6. PROBLEMS

(5.) Lack of reentry experience at GYM and MUC.

(8.) Form 16 for entry into Mexico.

7. RECOMMENDATIONS

(5.) For one of the days of simulation, have one mission a one-orbit reentry, and another a contingency reentry over Australia.

(8.) Notify those responsible for passports of the need for a Form 16.

8. TRAVEL

Without a Form 16, our entry into Mexico is delayed. After passing everyone else through customs, the officials then prepare a special work permit for those flight controllers lacking the Form 16.

9. MEDICAL

No problems.

Thomas E. Moore
Thomas E. Moore
Flight Controller

TEM:sh

NASA - Manned Spacecraft Center
Langley AFB, Virginia
February 27, 1962

MA-6

REMOTE SITE TRIP REPORT

NAME TEXAS

NUMBER 16

PERIOD COVERED BY REPORT January 15, 1962 to February 22, 1962

1. Personnel.-

a. Control Team Personnel

- | | |
|-------------------------|----------------------|
| (1) George C. Guthrie | Capsule Communicator |
| (2) Albert W. Barker | System Monitor |
| (3) Dr. George B. Smith | Medical Monitor |
| (4) Dr. H. D. Hansen | Medical Monitor |

b. M and O Team Personnel

- | | |
|----------------------|------------------------------|
| (1) Jim DeLong | M and O Supervisor |
| (2) M. C. Whitehurst | Assistant M and O Supervisor |
| (3) Morton Brandt | Site Manager |
| (4) Floyd Fannon | Telemetry Supervisor |
| (5) Albert Brumbelow | GCC |
| (6) Louie LeBlanc | Communication Technician |
| (7) Bob Neighbors | Radar Supervisor |

2. Mission Summary.- The Mercury tracking site at Corpus Christi, Texas participated fully in the complete network countdown as required. There were no serious malfunctions or difficulties during the entire countdown or during the following in-flight time. The performance of the site personnel and equipment was excellent.

During all three passes, the telemetry contact with the capsule was solid for about five to six minutes with some overlap with the neighboring

sites of Guaymas, California and Cape Canaveral. No voice contact with the capsule was established during the first pass since the voice handover was made directly from Guaymas to Cape Canaveral. Voice contact was excellent for the second and third passes. During the third pass, instructions were relayed to the astronaut from the Cape not to drop the retro package and to manually retract the periscope. The radar tracking during all three passes was received by Goddard with no difficulty.

3. Site Status.-

a. Personnel.- The site personnel continue to show a high degree of competence and a willingness to extend themselves when the need arises. Both the Site Manager and the M and O Supervisor show an exceptional willingness to cooperate with the flight controller team.

b. Equipment.- The equipment status at the Corpus Christi site is good. Lights indicating telemetry solid, broken or invalid were installed on the Capsule Communicator's console and proved very helpful. Also the button placing the air-to-ground loop on the Goddard loop was moved from the M and O console to the Capsule Communicator's console. This is very helpful in coordinating this circuit properly.

c. Facilities.- See previous trip reports from Texas.

d. Communications.- Communication to MCC is by voice and teletype. These circuits are reliable and without special problems.

4. Documentation.- No comment.

5. Simulation.- The first three network simulations for the MA-6 mission were helpful in site preparation and in re-establishing smooth working procedures among site personnel and the flight control team. There was, however, some lack of realism common to these practice missions, listed as follows:

a. No usage rates for fuel, oxygen and coolant quantities were seen on the systems or medical monitors' console at any time during the simulated passes.

b. High thruster activity was not simulated even though the circumstances of the simulated mission would require it.

c. Horizon scanner outputs did not appear to follow gyro attitude indications properly even when the ASCS was asserted to be acting normally.

d. Failure of capsule telemetry over Texas during the second pass seemed a rather frivolous failure to practice and reduced the team's opportunity to participate effectively in the network drills.

The simulations added to the schedule as a result of mission postponements had a rapidly decreasing utility for the site personnel and flight controller team.

6. Problems.-

a. The first problem was caused by simulation and concerns the confidence tape which had an excessive number of drop-outs. This tape seemed to deteriorate rapidly with use and fluctuations of 4-6 percent in segment readings became rather common. In addition, the off-scale readings proved less valuable than nominal readings.

b. The second problem also concerned simulated missions and the medical monitors' readouts. The medical monitors feel that live EKG's and respiration traces could and should be recorded on simulation tapes. Although integration with mission emergencies might be absent, the displays could be interpreted and would give the medical monitors some familiarity with customary individual variations. The sine wave respirations and artificial EKG's are considered useless by the medical monitors. The point is worth noting that the EKG's identified as Glenn's on the confidence tape for this mission actually belong to another astronaut.

c. The pens on the Sanborn recorders were left calibrated to forty divisions instead of the fifty divisions as requested by the Cape. This request was not complied with because of the M and O Supervisor's recommendation. His reasons were that the calibration becomes nonlinear with the expansion to fifty divisions and that there is danger of fouling the timing pens with adjacent data pens. The systems monitor was informed that an explanatory message would be sent to the Cape immediately after launch day by the M and O Supervisor.

7. Recommendations (Simulations).- The following procedure is suggested for making simulation tapes more realistic and more flexible.

a. Record live electrocardiograms and respiration taken from each of the possible astronauts.

b. On the commutated track, record approximately 50 segments at levels from 0 to 100 PFS in 2 percent steps. Remaining segments could be utilized in any desired manner, e.g., control movements, attitude displays, etc. With this commutated track, any console display could be accomplished by patching.

8. General.- No additional information is available beyond the information submitted in earlier reports from Texas.

9. Medical.- No comment.

George C. Guthrie
George C. Guthrie
Capsule Communicator

ORBITAL FLIGHT OF
JOHN H. GLENN, JR.

HEARING

BEFORE THE

SENATE COMMITTEE ON AERONAUTICAL
AND SPACE SCIENCES

TESTIMONY OF ASTRONAUTS AND NASA OFFICIALS

HELD ON

FEBRUARY 28, 1962



WORD ONE/KEYSEARCH

D:02-28-62 USS N:79 RMER Orbital Flight of John H. Glenn Jr. USS Roll2A

MARCH 15, 1962.—Ordered to be printed with illustrations

U.S. GOVERNMENT PRINTING OFFICE

51129 O

WASHINGTON : 1962

Senator HOLLAND. You hope, then, for the time when the man inside the capsule will be able to direct the capsule as it travels.

Colonel Glenn. Yes, sir.

Senator HOLLAND. Mr. Chairman, I have a friend at the

Mr. Wagon. Mr. Chairman, I have a friend at the

have a friend at the

SENATE COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES

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RICHARD R. WOLFE, Technical Assistant

S. Res. 317

IN THE SENATE OF THE UNITED STATES,
March 16, 1962.

Resolved, That the hearings conducted on February 28, 1962, by the Senate Committee on Aeronautical and Space Sciences entitled "Orbital Flight of John H. Glenn, Jr.," shall be printed, with illustrations, as a Senate document, and that there shall be printed nine thousand additional copies of such document for the use of the Committee on Aeronautical and Space Sciences.

ATTEST:

FELTON M. JOHNSTON, Secretary.

Senator PASTORE. Before the committee this morning that we are living in an open society, that in much of our activity in the past there has been a great deal of secrecy

capsule and we have our necks out, of course, where the other people don't. We don't deny that at all. But beyond that point we are merely scareheads. We are representatives for a tremendous pyramid of technical and scientific work that is hard to believe until you are actually involved in the program. We are really the representatives for all those people doing all this work, and that is actually the way we feel about it. We are not just paying lip service to that. It is a big, hardworking team together, and it has been that way all the way through.

MORE CAN BE GAINED FROM EXPERIMENTS WITH A MAN ABOVE

Senator Cawthon, Colonel Glenn said that one of the most important things you discovered in space, and you also found out that the particular area that we have failed had it not been for a certain amount of time, because of the fact that there has been a lot of things that we have not been able to do.

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III

When we are not in space, we are now, at that time, we can go out into space and make tremendous gains, where, if you can gain all of this in advance and send it out on a space vehicle and back, you have no flexibility at all. I think we are at the point now where we can foresee in the future possibilities that will enable us to do a lot of these things.

Perhaps some of the other fellows would like to make comments on that.

The Chairman: Commander?

MAN: IS AN EXCELLENT AND RELIABLE "COMPUTER" IF PROPERLY TRAINED

Commander: Yes, sir. If I might, I would like to add a few words to what John has just said.

I think you cannot categorically say that man should be in every space vehicle. Obviously, there are conditions where you are investi-

the information received at Cape Canaveral. I also decided not to inform Astronaut Glenn of this situation until it became absolutely necessary.

As Friendship 7 started its last orbit, it became apparent that a decision would have to be made prior to the end of that orbit. The situation was as follows:



Greater Glory Lt. Col. John H. Glenn, Jr., astronaut.

I want to join with the others here in congratulating you, Colonel Glenn, and the entire team, the astronauts, the director of the program, and the thousands of people who worked on this project to make it a success, and help get America back into the position that they should have in the world, and I believe they see today.

In that connection, I think one of our great military leaders made a very good observation to me yesterday when he said that he was extremely happy when that the idol and the hero of the American teach-

ORBITAL FLIGHT OF JOHN H. GLENN, JR.

WEDNESDAY, FEBRUARY 28, 1962

U.S. SENATE,
COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES,
Washington, D.C.

The committee met at 10 a.m., pursuant to call, in the caucus room (room 318) of the Old Senate Office Building, Senator Robert S. Kerr (chairman) presiding.

Present: Senators Kerr, Anderson, Symington, Stennis, Young, Dodd, Cannon, Holland, Wiley, Smith, and Case.

Also present: Senators John O. Pastore, John Sherman Cooper, B. Everett Jordan, and Kenneth B. Keating.

Also present: Everard H. Smith, chief counsel; Carter W. Bradley, chief clerk; William J. Deachman, Dr. Glen P. Wilson, and William A. Reynolds, professional staff members; and Richard R. Wolfe, technical assistant.

OPENING STATEMENT OF CHAIRMAN KERR

The CHAIRMAN. The committee will come to order.

It is an honor to have here these great Americans who have brought such glory and prestige to our country. I sat in the joint meeting Monday and was thrilled to hear a stirring and historic message to the Congress. Colonel Glenn and his fellow astronauts have made us more proud to be Americans.

This new triumph in space has strengthened the confidence of our allies and increased the respect of unfriendly governments. In my lifetime I have never seen the imagination of the people so captivated or their hearts more touched than by the flight and safe return of Colonel Glenn.

The daring exploits and brilliant performance were obvious to the millions who watched and prayed throughout long hours of uncertainty. But the human qualities of Colonel Glenn and his fellow astronauts are giving to the world an authentic image of what Americans are really like. These are dedicated and brilliant young men with faith and courage and humility.

It was my pleasure to sit beside Colonel Glenn at lunch on Monday, and I congratulated him on his spirit of reverence and his faith in God. By his example and by his performance, Colonel Glenn has made a tremendous contribution to the spiritual uplift which has stirred the hearts of so many people in this Nation and around the world.

We are happy to have with us this morning Mr. Webb, the Director; Dr. Dryden, his first Deputy; Dr. Gilruth, the distinguished scientist in charge of Project Mercury, in company with these astronauts.

Without objection, we will place the biographies of these gentlemen in the record at this point.

(The biographies are as follows:)

JAMES EDWIN WEBB, ADMINISTRATOR

James Edwin Webb was appointed Administrator of the National Aeronautics and Space Administration on February 8, 1961, by President John F. Kennedy. As head of the scientific civilian space agency of the U.S. Government, he heads an organization of more than 17,000 employees, with an annual budget of about \$1 billion.

Webb came to his NASA position from a background in public service, law, aviation, business, and education. He is a former Director of the Bureau of the Budget and Undersecretary of State, and a veteran of more than 30 years in Marine Corps aviation. At the time of his appointment he was president and trustee of Educational Services, Inc., of the Massachusetts Institute of Technology, a nonprofit organization devoted to research and improvement in the teaching of physics in secondary schools; was engaged in several private business ventures; and was chairman of the Municipal Manpower Commission. He was also president of Meridian House Foundation.

Born October 7, 1906, in Tally Ho, Granville County, N.C., he is the son of John Frederick Webb and Sarah Gorham Webb. He was educated in the public schools in his native county and was graduated in 1928 with a bachelor's degree in education at the University of North Carolina. Later, he studied law at George Washington University, Washington, D.C. He was admitted to the bar of the District of Columbia in 1936. He holds honorary degrees from the University of North Carolina, Syracuse University, and the Colorado College.

At the start of his aviation career, Webb won his wings at the Naval Air Station, Pensacola, Fla., in 1931, and was commissioned a second lieutenant in the Fleet Marine Corps Reserve. He saw service in Marine Corps aviation in World War II, becoming commanding officer of the First Marine Air Warning Group. He is still in the Marine Corps Reserve, holding the rank of lieutenant colonel.

Webb first came to Washington in 1932 as secretary to Congressman Edward W. Pou of North Carolina. Two years later he became assistant to O. Max Gardner, general counsel to the Aeronautical Chamber of Commerce of America, leading organization in the aviation industry. In 1938 he joined the Sperry Gyroscope Co., New York City. Starting as personnel director and assistant to the president, he remained 8 years, rising to the position of vice president.

Following his war service, he rejoined Governor Gardner who was Undersecretary of the Treasury. In 1946, President Truman appointed Webb Director of the Budget. Under his direction, the Bureau prepared the first complete compilation of all Federal research and development activities for inclusion in the U.S. budget. Outgrowth of this was a study and report by Dr. John R. Steelman, which led to the establishment of the National Science Foundation.

In 1949, Webb left the Budget Bureau to become Undersecretary of State, which position he held for 3 years. During this time, he was instrumental in establishing a number of science attachés in U.S. Embassies.

After 1952, he was engaged in a number of private business activities, including aircraft manufacturing and accessories, oil equipment and supplies, banking and law. At various times he was a director of Kerr-McGee Oil Industries, Oklahoma City; McDonnell Aircraft Corp., St. Louis; Federal Home Loan Bank Board, Topeka, Kans.; Fidelity National Bank and Trust Co., Oklahoma City; and president of Republic Supply Co., Oklahoma City.

Among his other public service activities, he has been a member of the Advisory Council of the School of Industrial Management, Massachusetts Institute of Technology; Visiting Committee, Graduate School of Public Administration, Harvard University; Visiting Committee of the Harvard-MIT Joint Center for Urban Studies; Industrial Advisory Board of Oklahoma State University; and the Research Institute of the University of Oklahoma. He is general chairman of that university's southwest seminars in public responsibility.

In addition, he has served as a trustee of the following nonprofit organizations: University Film Foundation, Ames, Iowa; George Washington University, Washington, D.C.; Committee for Economic Development, New York City; Citizenship Clearing House of New York; Frontiers of Science Foundation of Oklahoma; and the Transportation Research Foundation.

He has been on a number of boards and committees, including the Oak Ridge Institute of Nuclear Studies, National Cancer Council, President's Advisory

Committee on Management, President's Committee to Study the U.S. Military Assistance Program, U.S. Department of Health, Education and Welfare, National Civil Service League, Kirkpatrick Foundation, Federal City Council, U.S. Committee for the United Nations, Career Executive Board, Better Business Bureau and Chamber of Commerce of Oklahoma City, National Municipal League, and the National Aeronautic Association.

Webb lives with his wife, son James Edwin, Jr., and daughter Sarah Gorham Webb at 3200 Idaho Avenue, N.W., Washington, D.C.

He is a Presbyterian, a Democrat, a Mason and member of the following: Phi Beta Kappa, Phi Delta Phi, Acacia, American Bar Association, District of Columbia Bar Association, Marine Corps Reserve Officers Association, American Political Science Association, American Society for the Advancement of Management, American Society for Public Administration, American Academy of Political and Social Sciences, Academy of Political Science, National Planning Association, Regional Science Association, American Petroleum Institute, Oklahoma Historical Society, University and Brook Clubs of New York City, Beacon Club of Oklahoma City, and, in Washington, D.C., the University, Army and Navy Country, National Capitol Democratic, Chevy Chase, and Metropolitan Clubs.

DR. HUGH LATIMER DRYDEN, DEPUTY ADMINISTRATOR

Born in Pocomoke City, Md., in 1893, Dr. Dryden earned a bachelor of arts degree in 1916 and a Ph. D. in 1919, both from Johns Hopkins University in Baltimore, Md.

Dr. Dryden joined the staff of the National Bureau of Standards in 1918. He was named Assistant Director of the Bureau in January 1946, and Associate Director 6 months later. During World War II he served on numerous technical groups concerned with aeronautics and guided missiles on behalf of the Joint Chiefs of Staff, the military services, and the National Advisory Committee for Aeronautics.

On September 3, 1947, Dr. Dryden became Director of Research of the NACA. On May 19, 1949, he was made Director of the NACA, and held this position until NACA was succeeded by the NASA. On August 19, 1958, upon appointment by President Eisenhower, Dr. Dryden assumed the duties of Deputy Administrator of the National Aeronautics and Space Administration, becoming the first Deputy Administrator of the NASA after its creation by Congress in the National Aeronautics and Space Act of 1958.

He is currently a member of several scientific committees advising Government agencies including the Department of Defense, U.S. Army, and U.S. Air Force. He is Alternate Representative of the United States to the United Nations Ad Hoc Committee on the Peaceful Uses of Outer Space. He is an adviser to the Science Advisory Committee to the President, and a member of the Standing Committee of the Federal Council on Science and Technology. He is a national delegate to the NATO Advisory Group for Aeronautical Research and Development.

Dr. Dryden is home secretary of the National Academy of Sciences; honorary fellow and former president of the Institute of the Aeronautical Sciences; honorary fellow of the Royal Aeronautical Society; fellow of the American Academy of Arts and Sciences, and a member of a number of other professional organizations and clubs.

He holds honorary degrees from Polytechnic Institute of Brooklyn, New York University, Rensselaer Polytechnic Institute, University of Pennsylvania, Western Maryland College, Johns Hopkins University, and University of Maryland.

Dr. Dryden is married and has three children, a son, Hugh Latimer, Jr., and two daughters, Nancy Travers Dryden and Mrs. Andrew Van Tuyl, of Silver Spring, Md. The Dryden family lives at 5606 Overlea Road, Washington, D.C.

ROBERT R. GILRUTH, DIRECTOR, SPACE TASK GROUP

Robert Rowe Gilruth, Director of Space Task Group, Langley Field, Va. Home address: Chendale Road, Scaford, Va. Date and place of birth: October 8, 1913, Nashua, Minn. He has had 23 years' Government service (EOD January 4, 1937). Married, has one daughter. Received B.S. degree in aeronautical engineering June 1935; M.S. degree in aeronautical engineering December 1936, University of Minnesota.

Mr. Gilruth entered on duty at the Langley Laboratory of the National Advisory Committee for Aeronautics on January 4, 1937. He began his career in the Flight Research Division where he undertook a series of investigations related to the flying and handling qualities of airplanes. This work culminated in the now classic NACA Report No. 755 entitled "Requirements for Satisfactory Flying Qualities of Airplanes." This work provided the basis for the establishment of quantitative requirements for the flying and handling qualities of both military and civil aircraft in this and other countries.

In early 1945, Mr. Gilruth was selected by NACA management to create and establish an organization and facility for conducting free-flight experiments with rocket-powered models at transonic and supersonic speeds. This activity resulted in the development of the Pilotless Aircraft Research Division and of what is now the NASA Wallops Station launching site. These installations gained international recognition for their contributions to the science of transonic and supersonic flight and for the development of many techniques of conducting aerodynamic, propulsion, and structures research utilizing rocket-propelled models in free flight that have since been adopted by similar installations throughout the Western World.

In 1952, in recognition of his leadership and his pioneering and superior contributions to the science of flight and research techniques, Mr. Gilruth was designated as an assistant director of the Langley Laboratory with responsibility for directing the efforts of three research divisions: pilotless aircraft, structures, and dynamic loads. In this capacity, he directed the further development of high-speed research techniques in free flight and the development of equipment and techniques for research in high-temperature structures, materials, and aircraft loads.

In October of 1958, Mr. Gilruth was assigned to direct this Nation's initial program for achieving manned space flight, now known as Project Mercury.

Mr. Gilruth's technical achievements have been recognized by his receiving the 1950 Sylvanus Albert Reed Award, the Federal Government's superior accomplishment award in July 1951, the Outstanding Achievement Award from the University of Minnesota in October 1954, and the NASA Distinguished Service Medal.

Mr. Gilruth's outside interests are primarily concerned with boating. He is the inventor of this country's first successful hydrofoil system which allows boats to be operated at heretofore unprecedented conditions of high speed and rough water.

Mr. Gilruth was elected a fellow of the Institute of Aerospace Sciences in 1959.

JOHN HERSCHEL GLENN, JR., ASTRONAUT

John H. Glenn, Jr., a lieutenant colonel in the U.S. Marine Corps, was born July 18, 1921, in Cambridge, Ohio. He considers New Concord, Ohio, his permanent home. He is 5 feet 10½ inches tall, weighs 168 pounds and has green eyes and red hair. His wife is the former Anna Margaret Castor, daughter of Dr. and Mrs. H. W. Castor. The Glenns have two children: John David, 14, and Carolyn Ann, 13. His parents are Mr. and Mrs. John H. Glenn. The elder Mr. Glenn is a retired operator of a plumbing and heating business. The elder Glenns and Castors all live on Bloomfield Road in New Concord. Glenn also has a sister, Mrs. Jean Pinkston, of Cambridge.

Glenn attended primary and high schools in New Concord and attended Muskingum College there also. Glenn entered the Naval Aviation Cadet program in March 1942. He was graduated from this program and commissioned in the Marine Corps a year later. After advanced training, he joined Marine Fighter Squadron 165 and spent a year flying P-4U fighters in the Marshall Islands. During his World War II service he flew 59 combat missions. After the war, he was a member of Fighter Squadron 218 on North China patrol and had duty in Guam. From June 1948 to December 1950, he was an instructor in advanced flight training at Corpus Christi, Tex. Glenn then attended amphibious warfare at Quantico, Va. In Korea he flew 63 missions with Marine Fighter Squadron 311 and 27 while an exchange pilot with the Air Force in F-56 Sabrejets. In the last 9 days of fighting in Korea, he downed three Mig's in combat along the Yalu River. After Korea, Glenn attended Test Pilot School at the Naval Air Test Center, Patuxent River, Md. After graduation, he was project officer on a number of aircraft. He was assigned to the Fighter Design Branch of the Navy Bureau of Aeronautics in Washington from November 1956 to April 1959, during which time he also attended the University of Maryland. In April 1959 he was selected as an astronaut for Project Mercury.

Glenn has been awarded the Distinguished Flying Cross on 6 occasions, holds the Air Medal with 18 clusters for his service during World War II and Korea, and the NASA Distinguished Service Medal. In July 1957, while project officer of the F-8U, he set a transcontinental speed record from Los Angeles to New York, spanning the country in 3 hours 23 minutes. This was the first transcontinental flight to average supersonic speed.

The Glenn family hobbies are boating and water skiing.

ALAN BARTLETT SHEPARD, JR., ASTRONAUT

Alan B. Shepard, Jr., a commander in the U.S. Navy, was born November 18, 1923, in East Derry, N.H. The 33-year-old astronaut is 5 feet 11 inches tall, weighs 160 pounds, has blue eyes and brown hair. Shepard is married to the former Louise Brewer, of Kennett Square, Pa. The couple has two daughters: Juliana, 9, and Laura, 13. His parents, Col. and Mrs. Alan B. Shepard, live in East Derry where the elder Shepard, a retired officer of the Army of the United States, is an insurance broker. Shepard's sister, Mrs. Pauline S. Sherman, resides in Attleboro, Mass.

Shepard attended primary school in East Derry and was graduated from Pinkerton Academy, Derry, N.H., in 1940. He studied 1 year at Admiral Farragut Academy, Toms River, N.J., and then entered the Naval Academy, Annapolis. He was graduated from Annapolis in 1944. He was graduated from the Naval War College, Newport, R.I., in 1955.

The astronaut saw service on the destroyer *Cogswell* in the Pacific during World War II. He then entered flying training at Corpus Christi, Tex., and Pensacola, Fla. He received his wings in March 1947. Subsequent service was in Fighter Squadron 42 at the Norfolk Naval Air Station and Jacksonville, Fla. He also served several tours aboard aircraft carriers in the Mediterranean. Shepard went to USN Test Pilot School at Patuxent River, Md., in 1950 and served two tours in flight test work there. During this service he took part in high altitude tests to obtain data on light at different altitudes and on a variety of air masses over the North American Continent. He also took part in experiments in test and development of the Navy's inflight refueling system, carrier suitability trials of the F-2H3 Banshee, and Navy trials of the first angled carrier deck. Between his flight test tours at Patuxent, Shepard was assigned to Fighter Squadron 193 at Moffett Field, Calif., a night fighter unit flying Banshee jets. He was operations officer of this squadron and made two tours with it to the Western Pacific on board the carrier *Oriskany*. He has been engaged in the test of the F-3H Demon, F-8U Crusader, F-4D Skyray, and F-11F Tigercat. He was project test pilot on the F-5D Skylancer. The last 5 months at Patuxent were spent as an instructor in the Test Pilot School. After his graduation from the Naval War College, Shepard joined the staff of the commander in chief, Atlantic Fleet, as aircraft readiness officer.

Shepard has been awarded the NASA Distinguished Service Medal.

Shepard's hobbies are golf, ice skating, and water skiing.

VIRGIL IVAN GRISOM, ASTRONAUT

Virgil I. Grissom, a captain in the U.S. Air Force, was born April 3, 1926, in Mitchell, Ind. He is 5 feet 7 inches tall, weighs 150 pounds, has brown eyes and brown hair. Mrs. Grissom is the former Betty L. Moore. They have two sons: Scott, 11, and Mark, 7. Grissom's parents, Mr. and Mrs. Dennis D. Grissom, live at 715 Baker Street, Mitchell. He has two brothers and a sister: Norman, of Mitchell; Lowell, a senior at Indiana University, and Mrs. Joe Beavers, of Baltimore, Md. His wife's father, Claude Moore, lives in Mitchell; her mother is deceased.

Grissom attended primary and high schools in Mitchell. He first entered the Air Force in 1944 as an aviation cadet and was discharged in November 1945. He was graduated from Purdue University with a degree in mechanical engineering in 1950. He returned to aviation cadet training after his graduation from Purdue and received his wings in March 1951. Grissom joined the 75th Fighter-Interceptor Squadron at Presque Isle, Maine, as an F-86 fighter pilot. He flew 100 combat missions in Korea in F-86's with the 334th Fighter-Interceptor Squadron. He left Korea in June 1952 and became a jet pilot instructor at Bryan, Tex. In

August 1955 he went to the Air Force Institute of Technology at Wright-Patterson Air Force Base, Ohio, to study aeronautical engineering. In October 1956 he attended the Test Pilot School at Edwards Air Force Base, Calif., and returned to Wright-Patterson Air Force Base in May 1957 as a test pilot assigned to the fighter branch.

Grissom has been awarded the Distinguished Flying Cross and Air Medal with Cluster for service in Korea and the NASA Distinguished Service Medal.

His hobbies are hunting and fishing.

The CHAIRMAN. Mr. Webb, would you say a word to the committee and make such presentation as you desire and then it is our hope that each member of the committee may have 5 minutes in which to ask questions of any of the astronauts they desire.

STATEMENTS OF JAMES E. WEBB, ADMINISTRATOR; DR. HUGH L. DRYDEN, DEPUTY ADMINISTRATOR; AND DR. ROBERT R. GILRUTH, DIRECTOR OF THE MANNED SPACECRAFT CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; AND LT. COL. JOHN H. GLENN, JR., CAPT. VIRGIL I. GRISSOM, AND COMDR. ALAN B. SHEPARD, JR., ASTRONAUTS

Mr. WEBB. Thank you, Mr. Chairman. We deeply appreciate in the National Aeronautics and Space Administration the willingness of your committee to interrupt its important work on the communications satellite program in order to permit this visit by our distinguished Project Mercury officials and astronauts.

Let me say in the beginning that while the presentations we are making to the House committee on the authorization for 1963 include a relatively small amount for Project Mercury, some \$13 million, there is a very large amount for the Project Apollo and the boosters to carry on a further program of manned space flight. In addition to those funds there are funds for Project Gemini, which is an interim program, a two-man spacecraft program, designed for a large amount of flying in the immediate vicinity of the earth, to learn more and more with each flight about how man can operate effectively and carry his own environment with him out into space.

CORRECTION OF WESTFORD STATEMENT

Now, before I introduce Dr. Gilruth, the manager of Project Mercury, there is a correction of the record of yesterday. Mr. Chairman, although I was not able to be with you because of the appearance in the House, I know your committee found in Dr. Dryden one of the wisest witnesses that you have had, but even the wisest men at times misspeak themselves, so Dr. Dryden has a correction of the record to make, if you please.

Dr. DRYDEN. This will take just 30 seconds. I stated the Department of Defense would launch a second attempt at Project Westford. I find that the matter is still under consideration, and no decision has been made. Thank you.

The CHAIRMAN. I would say that both statements are par for the course.

INTRODUCTION OF DR. GILRUTH

Mr. WEBB. I know from the experiences that we had last year with your committee in the careful examination you made of the

NASA program, and particularly the manned space flight program, that you are interested in providing the funds, resources, and authority to do the job, but you are very anxious that it be done right and that prudent and efficient management be involved. I should like to start by introducing Dr. Robert Gilruth, who for 3 years has been the project manager.

You know, before we could have a Project Mercury, or before we could have an astronaut, we had to have the commitment of the leadership of this Nation to do the job. That has been forthcoming. Dr. Gilruth undertook to do it, and he has expended some \$400 million in this project, and I should like to introduce him to the committee.

This is Dr. Robert R. Gilruth.

The CHAIRMAN. Dr. Gilruth?

Dr. GILRUTH. Mr. Chairman, it is a great privilege and honor to be here. I know you want to hear from the men that have actually flown in space, and I would just have one suggestion here. I would like to ask Gus Grissom to discuss one phase of the program that has received relatively little cover and yet has been a very vital and important part of it. That has to do with the very extensive training that has been done in the various novel devices that have been used by the seven astronauts to get as fit and as ready and as experienced as was humanly possible to get them on ground-based equipment before the actual rise into space. Gus, would you take over and run down that program for us?

I can't say that. It is a very important part of the program.

Captain GRISSOM. Mr. Chairman, a lot has been said about our training program in the past. While it is true it has been a long training program, some 3 years, and at times it has been quite difficult, the three of us have found from our flight experience that it has trained us well. It has been an adequate program, and in our discussions we cannot really think of anything that we have omitted or really anything that we have had too much of.

For instance, on the centrifuge program that we run in Pennsylvania, we undergo launching, acceleration, and reentry accelerations, and to a certain extent we overtrained a little bit in that we have taken accelerations up to 16 g.'s, where on a normal launch and reentry we do not expect to run into anything more than about 8 g.'s, or as to the flight that Al and I took on the Redstone, we took about 11 g.'s on reentry, so we are well prepared for those accelerations.

We also have flight simulators, both at the Langley space group and at Cape Canaveral, where we trained ourselves in the flight program and to go into the capsule and emergency procedures. They are used to train the ground personnel, also. We use it in conjunction with our worldwide range, to train systems monitors and capsule communicators all around the world.

The astronaut actually gets in the simulator and is in contact with these people in the building, and at times even the people as far away as Australia.

I cannot go through all of the training programs we have had, but the one that was especially important to me was some of the recovery work that we did. A good deal was done at Pensacola, one of the naval stations, and this was concerned with getting out of the capsule

LESS AUTOMATION MAY BE NEEDED IN FUTURE

Colonel GLENN. Mr. Chairman, I think that probably I might generalize a moment on the two major things. Mainly in a philosophical field, as far as future design concepts go, was the proof on this flight that a man can operate in this new and completely strange environment and operate satisfactorily. I think that in the future we will probably be able to maybe put less automation into some of our machines than was included in the Project Mercury design. This was necessary in the Project Mercury design and we did not dispute that with the other engineers and scientists who were working on the project, because on this first time out we did want to make sure we got the man back if we in fact found out that the man was not capable of operating in this new environment for a period of time.

But I think in the future we probably can; in other words, we can plug man into the system here and make him a part of the system that we rely on to take intelligent action while he is in space, and thus get by with a lot less automation maybe than we have in the past.

The CHAIRMAN. Tell us, in your judgment, what you found out and what NASA found out by reason of the fact that you were in this capsule and manually operated it a portion of the time that could not have been learned without you or another efficient astronaut being in it, acting in that capacity. In other words, what did you find out that required a man being there to find out?

COLONEL GLENN WAS ABLE TO CONTROL CAPSULE

Colonel GLENN. Well, we found the main thing, of course, was when we ran into trouble with the automatic stabilization and control system, where with just the capsule without a man aboard we would probably have had to end the mission right there or bring it back in early, or there might have been some question about whether we could even have gotten it back or not.

At that point I was capable of taking over and controlling the capsule and controlling the attitude of the capsule and making what I hope were intelligent decisions with regard to bringing it back in coordination with the people on the ground. This certainly would have been impossible had a man not been aboard.

ASTRONAUTS WILL BE ABLE TO NAVIGATE USING STARS

Commander SHEPARD. Could I add something to that, Mr. Chairman? I just thought of something which John has not covered in the past few days, and I think which very definitely indicates that we learned something on this flight. There has been a question for some time as to how visible would stars be during daylight, and I think extrapolating this bit of information ahead, we intend to use the old method which seamen have used for years, on the way to the moon, that is, using the stars to provide a fix and provide location and navigation aids.

I think that John's observation of the stars during his flight, during the daylight hours, indicates that we indeed have a possibility to use this method for space navigation. This was just a point which

Mr. Webb brought out, and I thought that you would be interested in that observation.

MORE COMPLETE DATA WILL BE AVAILABLE LATER

Colonel GLENN. If I might continue with just one other word, Mr. Chairman, a lot of these things we may be a little bit vague on at the moment because we have had practically no opportunity to go over any of the results from the flight ourselves. Data are being worked out now in Cape Canaveral, and I expect to go back there very shortly to get back to work again, I hope.

There are many, many things that I think will be coming out in the next few weeks as a result of the flight, from review of the onboard tape recordings, and the cameras on board that recorded both a view of the instrument panel and a view of me during the flight. So these are really general views that we are giving you now, and I am sure that we will have more specific data later if you would care to have us come back at a later date.

The CHAIRMAN. I assume then from your answer that you are telling us that we will make greater progress and achieve our objectives sooner and do it with more efficiency and greater value with a manned spacecraft than with just the spacecraft in orbit, controlled mechanically from the ground.

Colonel GLENN. I am sorry I didn't put it in those words myself, sir.

The CHAIRMAN. Senator Smith, do you take that as a compliment?

Senator SMITH. Whether they are the colonel's words or yours, I certainly do.

BASIC, GOOD, SOUND EDUCATION IS A PREREQUISITE

The CHAIRMAN. What training, Colonel, would you recommend to young Americans who would like to have some direct part in this new space age, whether they want to be astronauts or be a part of the program backing them up?

Colonel GLENN. Yes; I feel very strongly, Mr. Chairman, that this is one of the finest byproducts of the whole program, really—is the inspiration maybe to greater effort in these fields that we can pass on to the people who will come along after us, those who are in their education years right now. I think that really is the crux of the whole thing if we expect to stay in a position of leadership in this field.

We need trained people very much. Whether they go into training directly as astronauts, as we have done, or whether they are in all of the many supporting fields or whether they are in a differing science field in general, a basic, good, sound education is a prerequisite to any progress in this field.

My best advice to anyone starting out in this field, as we have given many times in letters to people writing in to us, is just to get the finest basic, good, general education they can. Let their own talents then beyond that point guide them into what particular area they should be in, but I think a good, sound, basic education is certainly a prerequisite to any activity in this field.

The CHAIRMAN. Thank you very much, Colonel. If I have time when the other Senators have asked you questions, I will have another one, but at this time I call on Senator Anderson.

INTRODUCTIONS TO THE AUDIENCE.

Senator ANDERSON. I was going to suggest, Mr. Chairman, that a lot of people in the back of the room haven't had a very good look at them. Would you mind if I used a minute of my time to ask Colonel Glenn to turn around and face the back of the room and smile to the people.

The CHAIRMAN. And also Captain Grissom and Commander Shepard. [Applause.]

Mr. WEBB. And I suggest Dr. Gilruth, who has been the manager of the program.

Senator ANDERSON. I was coming to that. [Applause.]

Well, thank you. I want to assure you, Commander Shepard and Captain Grissom, that I was going to suggest that individually you folks do the same thing, but as long as you all did it together, that is fine.

Colonel GLENN. Gus was embarrassed to do it, but as he turned around, Gus saw his sister sitting back here. We might have her stand up.

Senator ANDERSON. Let her stand up. [Applause.]

Mr. WEBB. Senator Anderson, the wives of our astronauts are here, and maybe Senator Kerr would yield you 1 minute to let them stand up.

The CHAIRMAN. We would like to have their wives stand.

Mr. WEBB. They are Mrs. Shepard, Mrs. Grissom, and Mrs. Gilruth.

Colonel GLENN. My wife is at home getting the kids in school today.

Senator ANDERSON. She is entitled to that vacation. Well, thank you very much, because I realize these people are very, very anxious, as all America is, to see you.

MANY PEOPLE COULD BE TRAINED AS ASTRONAUTS.

You spoke of the training program and Captain Grissom told how essential it was that this be done. A great many people are saying if you do not allow these three men to go back up again, is there anybody else that can fly the spacecraft other than the backup astronauts? Are not there literally hundreds and thousands of young Americans who could be trained as astronauts? In other words, is our program hampered by only a few men being able to fly a spaceship? Colonel, what would you say?

Colonel GLENN. Well, obviously, there are many, many people that could be trained to do this job. Starting out on a new project like this, the ground rules were set up for the type of people NASA wanted, and they felt that military test pilots probably had the best background to be sort of a take-charge type of person in case of emergency or in case of difficulty on the spacecraft. These were people who were used to being in all different kinds of g. fields and tolerances and used to using oxygen masks and so many different things that went into their background.

They were used to coping with emergencies, and this was a type of person they looked for on these early programs.

I think that this was a valid selection on this criteria, and I think it will probably remain so at least for the immediate future. When

we get to boosters of sufficient size where we can carry more people aboard, then perhaps there will be a reason for making people of other disciplines also members of the crew. But at least for the immediate time period we are talking about, we feel that the same type of people should be selected for future programs. The numbers of people that you mentioned, though, I think is surprising, if you figure up all of the missions that we can possibly plan in the next 10 years, the crew requirements are not too large. We don't envision a crew training program involving thousands of astronauts, for instance, and I am afraid we would all be bankrupt if we tried it.

Senator ANDERSON. I appreciate that answer, because some people are worried that the program might be held back because there were not sufficient astronauts to carry it on.

Captain GRISOM. Senator Anderson, I think you stated that the three of us would not be permitted to make other flights. No one has told me this, and—

Senator ANDERSON. I said "if."

Captain GRISOM. I wanted to make sure that this wasn't the general impression.

Senator ANDERSON. I merely said "if you didn't," because some people said that we must not rob our country of their experience and they must not go up again. I imagine you are anxious to go, and we are anxious to have you, at least I am. But if that was so, lack of interested candidates is not one of the things that will hold back the program.

GEMINI CAPSULE WILL BE LARGER AND CAPABLE OF CARRYING TWO ASTRONAUTS

Now, you mentioned the fact that man could control. If you remove from the capsule some of the automatic controls, would you have space and weight available to allow two men to go, for example, with pretty much the same equipment you now have?

Commander SHEPARD. The answer to that question with respect to our present capsule is that, generally speaking, it would provide us with a weight capability to put an extra man in there, but there is not at the moment additional space, to coin a word. We are taking steps already for some of our Mercury capsules which are to be launched toward the end of this year or early next year, to remove some of this automatic equipment.

To follow the program which Mr. Webb and his team are presenting to these appropriations hearings on the project called Gemini, this has been designed to carry two people from the start, and the capsule is larger, and provides that capability.

Senator ANDERSON. Would you be able to take out all of the automatic controls?

Commander SHEPARD. These determinations will be made in our design concepts as we go along with future designs.

Senator ANDERSON. When the two-man craft goes up, would you like to be on it?

Commander SHEPARD. Me?

Senator ANDERSON. Yes.

When the Gemini program is started, I will be available one, but at this time I call on Senator Anderson.

Commander SHEPARD. Very definitely.

Senator ANDERSON. And you, Captain?

Captain GRISSOM. Yes, sir.

Senator ANDERSON. Colonel, I assume you would, also?

Colonel GLENN. They tell me to say "Yes," and I didn't hear the question.

Senator ANDERSON. Well, this would not be the first time that the witness was coached before he addressed the committee.

Mr. Chairman, I do not think I have additional questions, and I know that we are all anxious to give all of the members of the committee a chance to ask questions. I know that we all deeply appreciate the fact that you are here, gentlemen. The fact that we do not all ask you a great many questions is only evidence of our joy in having you here.

The CHAIRMAN. Thank you very much, Senator Anderson. Senator Wiley?

Senator WILEY. I join with you, Mr. Chairman, in saying thanks to these men for a wonderful sense of courage and poise that they have demonstrated. I have just one or two questions.

COLONEL GLENN GIVES MOVING TESTIMONY OF RELIGIOUS FEELINGS

When you were up there this last time, Colonel, what were your thoughts really in relation to your faith?

Colonel GLENN. I had some very definite feelings on that, Senator. I can't say that while in orbit you sit there and pray, or anything like that. It is a very busy time. There have been people in the past who have tried to put words in my mouth that at a certain time I suddenly lapsed into a prayerful state, or something like that, and this just isn't the case. I feel we should live all of our lives every day as though that were going to be the last day. Now, I fall so far short of this every day that it is pitiful, but we come back and keep trying the next day anyway.

But I feel that to me at least my religion is not a "fire engine" type of religion and not something that I call on in an emergency and then put God back in the woodwork in his place at the end of a particularly stressful period. We try to live every day as best we can, and I think that is the way. I would say the same thing happened on the orbital mission. My peace has been made with my Maker for a number of years, and so I have no particular worries about the future along that line. [Applause.]

Senator WILEY. From what you have said on other occasions, I was wondering whether you felt that God was up there as well as down here, and that in Him you lived and moved and had your being?

Colonel GLENN. Absolutely; I think to try to limit God to one particular section of space or something is a very foolish thing to do. I don't know the nature of God any more than anyone else, nor would I claim to because I happened to have made a space ride that got us a little bit above the atmosphere. God is certainly bigger than that, and I think He will be wherever we go. [Applause.]

the one that was especially important to me was some of the teamwork that we did. A good deal was done at Pensacola, one of the naval stations, and this was concerned with getting out of the capsule

DREAMS ARE ALWAYS ONE JUMP AHEAD OF POWER CAPABILITY

Senator WILEY. What do you see in the immediate future as to improvement in the mechanism?

Colonel GLENN. I think that the projects being outlined here by Mr. Webb and other NASA officials pretty well define what we see as the future mechanisms. Immediately we are looking forward, of course, to 18-orbit missions with an improved version of our present capsule, and the next step beyond that will be the Gemini project that Al mentioned, and extended missions with that, and the whole project that Mr. Webb will be outlining is the project, as we see it, for equipment.

As Mr. Webb reminds me here, too, more booster power is the crux of the whole thing; as we discussed yesterday before the House Committee, we can do anything that the powerplants will let us do. This has been the limiting factor, I guess, since man first invented the wheel. He has been power-limited, and as we said yesterday, his dreams and his plans always are one jump ahead of his power capability to keep up with the dreams and the plans. So as rapidly as powerplants are developed to permit us to use heavier equipment, the more progress we will make.

FIRST INFANT STEP INTO BEGINNING OF AN ERA

Senator WILEY. Well, do you visualize the improvement in the particular instrument that you had, the same as that we have seen between the canoe of the Vikings and the ships of today?

Colonel GLENN. There is a good sized spread between the ships of the Vikings to the ships of today. I think we are in such a new element that that might be just the beginning of some of the progress that we might make to the future.

Mr. WEBB. I would say we may be dealing more with a raft at the moment than a canoe, because we just have a vehicle that can exist and from which we can learn the other things we have got to know. We know it does not sink, and we know that we can carry our environment with it and live on it, but it is more like a raft, I think.

Senator WILEY. I will not argue that point. I just wanted to see whether you felt that there was this big opportunity, this big jump that should be made and can be made, in order for us to get further acquainted with what is out beyond. You believe in that, do you?

Colonel GLENN. I certainly do. I think that we are on the eve of an era or we have made the first little infant step into the beginning of an era, a whole new environment that is so big and has such a tremendous potential that it is difficult to even describe.

So far we have been limited to observations of our own atmosphere and our own earth. Now we are getting out into a completely new atmosphere. The things that we may run into, I don't think that we can even envision today. The benefits from this, the benefits that may accrue are difficult to even try and assess at this point.

The CHAIRMAN. Thank you very much; Senator Wiley, Senator Symington?

THESE ACCOMPLISHMENTS ARE A TONIC TO AMERICA AND THE FREE WORLD

Senator SYMINGTON. I thank Commander Shepard for honoring my hometown Saturday, and thank all three of you for what you have done for the Nation, and for the youth of America in belief and in faith.

In my opinion, one aspect that has not been adequately stressed is what you all have done for our prestige around the world. On various trips in recent years I have noted a growing apprehension of the efforts in the scientific field of other people. I think these space accomplishments are a tremendous tonic to America, and at least as much so to the friends of America all over the free world. I congratulate all three of you, and Director Webb and Mr. Gilruth.

Mr. Chairman, I have no questions.

The CHAIRMAN. Thank you, Senator Symington.

We are now happy to have not only one of the most intelligent, but certainly the most attractive features of our committee, Senator Margaret Chase Smith.

Senator SMITH. Mr. Chairman, I shall not ask any questions at this time, but I would like to suggest that the chairman ask his additional question on my time.

The CHAIRMAN. I am going to yield back to you, Senator, because the first question that Senator Wiley asked Colonel Glenn was the other one I was going to ask.

Senator SMITH. I shall still pass, Mr. Chairman. Thank you.

The CHAIRMAN. Senator Stennis?

"WE HAVE JUST COMPLETED THE THIRD HOP AT KITTYHAWK"

Senator STENNIS. Mr. Chairman, I have just a few questions for Colonel Glenn, who has already touched on this point with Senator Wiley.

Before the joint session, you said that this heralded a new era; to Senator Wiley you called it a new environment. What place in the development of the airplane would be comparable to where we are now with reference to space vehicles? Perhaps we are beyond the Kittyhawk, N.C., stage, but are we up to the World War I stage? Could you approximate that?

My next question would be, as a nation, do you think it would be just as serious for us to neglect the further development of space vehicles and the mastery of space as it would have been to have neglected airpower, we will say, following World War I.

Colonel GLENN. Senator Stennis, in regard to your first question as to our status of development as compared with airpower, of course this is very difficult to assess. I would say we had just completed the third hop at Kittyhawk right now. We are certainly not beyond that point.

SPACE PROGRAM WORTHWHILE EVEN WITHOUT RUSSIAN COMPETITION

Senator STENNIS. Very well. Now, on the second phase of that question, as to the vital necessity of moving forward toward further mastery of space, do you think it is just as essential, just as fraught with disastrous consequences, perhaps, if we fail?

Colonel GLENN. I think the program is so worthwhile and has such a tremendous potential for helping us understand the environment in which we live, and for the benefits that we don't even foresee now; it is such a tremendous field when you look at all the different things that can be done and all of the different areas that need investigation, and all of the different byproducts that may come from this, that I think this program is worthwhile even if there was no such country as Russia that we are in competition with.

SENATOR STENNIS. BYPRODUCTS ARE TREMENDOUS.

Senator STENNIS. Anyway, it is this new environment and it must be developed for many, many different reasons. That is your position?

Colonel GLENN. Yes, sir. This is not just a human experience that we place somebody out here. These are across-the-board scientific advances in all science fields when we go into this. The byproducts are tremendous.

Senator STENNIS. And a major part of the benefit, too, are the byproducts; is that correct?

Colonel GLENN. Yes, sir. A thing that comes to mind immediately is an ad I noticed in the paper the other day where some company is now advertising for general medical use the little biosensors, which we place on our bodies which have been developed during this program. These are such that they can be used while men are moving around, are active, and can give more reliable pickup than has ever been possible before. This is just one little example of where, in heart research, for instance, maybe one of these byproducts is falling out of our program right now and will benefit people in heart research. This is just one little example.

SENATOR STENNIS. ASTRONAUTS PERSONIFY THE GOOD THINGS ABOUT AMERICA.

Senator STENNIS. I emphasize this because it has not been fully understood. There have been efforts to reduce the appropriations for these programs. I think your counsel and advice to the American people will be very helpful, and I know it will be much easier now for those of us on the committee to support those appropriations.

May I say to you, too, that I personally feel that you and your coworkers have been a great medium for revival of spiritual feelings and spiritual values, and also personify so well the very best in Americanism. You inspire American youth, in contrast so markedly with all the negative things and the wrong things that we find, and that are being emphasized. You men are personalities that personify the good things about America, our freedoms, our liberty, our achievements. I certainly feel that you have made a contribution to these things we hold so dear.

I have a great interest in what you have said concerning manned operation of spacecraft because on the Armed Services Committee we have been concerned about movement toward weapons that did not have a human being connected with them in relation to the next generation of long-range bombers, the B-70. Now, you gentlemen that have gone into outer space come back with this clear report that even in outer space, it is a great advantage to have that human, manual control. This will be helpful to us in our deliberations in the Armed Services Committee.

PRAISE FOR DR. DRYDEN

Mr. Chairman, may I take just one extra half minute to commend Dr. Webb and his staff, and also to commend Dr. Dryden, whom I have known for many years. He used to come before the Armed Services Committee for just a few thousand dollars for some small buildings for the old NACA. I was impressed with him then as being a fine personification of true humility and dedicated public service, and, except within his limited circle of professional friends, unknown and partly unnoticed.

It is a great country that has men like Dr. Dryden, who come forward at just the right time, in an outstanding Government career.

The CHAIRMAN. Thank you, Senator Stennis. I could not be in more complete accord with you. I am impelled to say that you have so great a portion of the same elements in your own personality that it would be easy for you to recognize it in others and speak as an authority with reference to it.

Mr. WEBB. Mr. Chairman, could I suggest that you not have Senator Stennis set the precedent of calling me Doctor. I am the Administrator and never earned the doctorate.

The CHAIRMAN. I learned a long time ago, Mr. Director, that it is really immaterial what they call you, so long as they call you.

Senator STENNIS. Mr. Chairman, I read the newspapers, and Dr. Webb received a doctor's degree as late as last Saturday night.

The CHAIRMAN. I understand there is another college they are building by degrees.

The Senator from New Jersey, Mr. Case.

Senator CASE. Mr. Chairman, you are very sparky today, but you always are.

It is nice to have you gentlemen here today. We appreciate it. We appreciate it for yourselves and for the rest of your associates, and for the entire operation. I just have a couple of questions I will ask now, if I may.

COLONEL GLENN HAD NO NAUSEA; WEIGHTLESSNESS WAS VERY PLEASANT

The first question relates, Colonel, to the way you stood the trip. We have heard that one of the Soviet astronauts was ill during at least part of that trip that he had. Have you any idea why your experience was different?

Colonel GLENN. No; I don't. However, during our experience with zero g.—we were aware of the reports from Mr. Titov's flight. We have no specific information from those flights since they treat their coverage of this in a little different fashion than we do. However, my experience on this was that I had no ill effects from the weightless period at all, at least a period of this length.

Now, of course, the Russian cosmonaut went on a longer mission than we did, but I had no nausea, no tendency toward it at all; it was very pleasant. We described, I think, a few times how you can park things in midair, such as a camera, and some things like that which are very unusual under zero g. But as far as the body feelings and the sensations, it was very pleasant. We had no ill effects from it as has been reported by others.

DISCUSSION OF ZERO AND HIGH-G. FORCES

Senator CASE. There are some of these things, I suppose, that you can train for, as Captain Grissom stated. But I don't know that you can train yourself for being better able to stand some of these stresses, which may be a matter of selection; isn't that true?

Colonel GLENN. We had stressed only one thing in this line, Senator Case, and that is we be in as good physical condition as we could be at the time. We felt that if we prepared ourselves physically as well as we could, that was the best we could do in preparation for zero g. Zero g. is the one thing that is extremely difficult to simulate here on earth or in the atmosphere. We have made a number of zero g. flights in airplanes, but you are limited in just going up and pushing over into a weightless parabola that permits only at the maximum about 1 minute of simulated weightless flying. So that is not very long to try to acclimate to this new element.

I found that this was the easiest thing to adapt to that I have run into. There was no problem with overreaching switches or no tendency to nausea, at least for this length of flight. It was a very pleasant experience. Any of us that have a weight problem, if we got on the scale at that time, we would have no problem at all.

Senator CASE. Thank you very much.

Yes, sir?

Commander SHEPARD. If I could add just a few words to what John just said, we have several theories as to what might have caused the Russian's difficulties, and these theories were pretty thoroughly investigated before we went up. Primarily they had to do with sensations in the mechanisms of the inner ear, and this feeling is related to the spacecraft rotational velocities. These things John investigated to a small degree during his flight, and, of course, we will investigate to a greater degree during subsequent flights.

So the problem has not been ignored. We have theories, I think, which will enable us to investigate at a moderate pace.

Colonel GLENN. I might add one word to Al's comment. I probably should have elaborated on that a little bit more. We have been in various devices and machines that calibrated our tolerances to these various feelings. We have set up rotating rooms at Pensacola, and different devices, at exact rates to permit us to calibrate ourselves as to where we pick up various sensations, where we can sense certain movements, and how much aftereffect we get from it. We have a complete rundown on our own capabilities in this regard, so that, if we had run into trouble, we would know at about what rates they had occurred under the 1 g. We possibly could make some correlation to zero g. So this would back up what Al said 100 percent. We have not ignored this or hoped that the problem would go away. We were prepared to investigate it very thoroughly.

Senator CASE. I am sure it had not been ignored. The general point of my question was, I think, the same as that which Senator Anderson was getting at, that is, looking ahead. But it was just from the purely physical side, that the capacity to meet stresses strange to the body is not likely to be limited to just one person out of a million. Is that your general judgment? In other words, is the average person capable of being trained for this sort of thing?

Colonel GLENN. The University of Maryland, in Annapolis, had been used as a training center for Project Mercury.

Colonel GLENN. Anyone going into space will have to have special training, I think. In other words, the day when you can just go down and buy your ticket and climb aboard and get a safe passage for anyone in any physical condition won't be here for some time. We want to have crews trained so that they can take over in case of any emergency. This would require the highest physical conditioning, to be able to do this, just as it does for some of the more hazardous test flying. If you want to have the maximum safety, you want yourself to be in the best physical condition. I think this will go on into the future as we see it, at least the immediate future, in space flight.

Senator CASE. I am sure that is so, but, again, not to belabor the point, the capacity to meet these things, assuming proper training, is not something that is to be found in only maybe one out of a million people.

Colonel GLENN. Not at all; no. Certainly if we wanted to get into more and to greater numbers of flights, we would have no problem at all finding sufficient people to train for this. We are not that superhuman at all.

Senator CASE. I hesitated to ask the question because there was some implication that I thought you were, and I don't. This is only one of many qualities that produce this extraordinary result.

ASTRONAUTS ARE DOWN-TO-EARTH PEOPLE

Colonel GLENN. I think you will find all of our group of seven are pretty much down-to-earth people who have the same physical qualities and the same daily activities as many people do—well, many people in differing lines of work, and in particular those who are in military test flying.

Senator CASE. This is what I would like to believe more and more about this country, and it is encouraging to have you say it.

I have no further questions at this time. Thank you.

The CHAIRMAN. Thank you very much, Senator Case.

The Senator from Ohio, Mr. Young.

ASTRONAUTS PRAISED FOR DEMONSTRATIONS OF FREEDOM TO THE WORLD

Senator YOUNG. May I tell you, Colonel Glenn, that on the day of your great achievement, and this morning since 10 o'clock, there has really never been a time in my rather long life that I have been more proud of the fact that, like you, I was born and reared in Ohio. You, sir, demonstrated to all the world, you and your associates, the best that an open society and freedom can display before the entire world. By what you and your coworkers have done, I feel, and I know all of us feel, that never has the prestige of the United States of America been higher in the world than at the present time.

There are really no questions, but I am somewhat curious, sir, about this: During all of the time, were there ever some moments when there was an extraordinary occurrence or something that had not been envisioned, nor anticipated, by you in your training that should have caused—perhaps not in a brave man like you—should have caused a feeling of apprehension, something unexpected? Did anything like that occur during your flight, sir?

Colonel GLENN. No, sir. I think the flight was very smooth and very successful. I think the flight was very successful and very smooth. I think the flight was very successful and very smooth.

GLENN DESCRIBES "MOMENT OF SOME CONCERN" ON REENTRY
 Colonel GLENN. Yes, sir. There was the occurrence during reentry. We had kept the retropackage on because of a false indication, we have since found. Al called me from the capsule communicator's position and recommended, after consultation with practically everyone in sight at the cape, and long distance back to St. Louis, to the McDonnell plant, and all the experts on all of these various systems had recommended that we keep the retropackage in place during reentry. This is something we had considered as a possibility. We never have run tests on this during previous flights, but there had been wind tunnel tests conducted to see what would happen if this was ever necessary.

At the beginning of reentry, one of the straps that holds the retropackage in place had burned loose, and I could see it. It was up around the side of the capsule and I could see it from the window, so I knew for sure that the retropackage had been released. At the time it released, I felt a bump back on the capsule, and thought that the retropackage had come off and had been jettisoned as it was supposed to do. Apparently it was still in place back there even though the straps had broken or had come loose. So that during reentry instead of just having the heat shield back there, which I thought I had, I also had the retropackage still sitting on the heat shield. (See picture on p. 41 of Mercury capsule with retrorocket package.)

During reentry when you get up to high heat conditions, this retropackage started to tear up and was flaming. Pieces of it came back around the capsule and these could be seen through the window.

At that time, of course, I thought the retropackage had been long gone. So I was not certain at that time whether it was the heat shield coming apart or not. I could not quite imagine that it was the heat shield. We never had any indication of them tearing up like that. But on the other hand, I thought perhaps something had occurred by keeping the retropackage on there that had damaged the heat shield earlier.

So with these chunks coming off and coming back around the capsule, this was a moment of some concern, because you have to have that heat shield for reentry. If you don't, you would burn up.

(Senator Kerr subsequently requested Commander Shepard to submit a statement regarding the above incident. The statement is as follows:)

STATEMENT BY COMDR. ALAN B. SHEPARD, JR., ASTRONAUT

Senator Robert S. Kerr, of Oklahoma, requested that I provide detailed information concerning the difficulty with the heat shield experienced by Col. John H. Glenn, Jr., astronaut, during his orbital flight of February 20, 1962.

As the Friendship 7 spacecraft passed over Cape Canaveral, Fla., at the end of its first orbit, a telemetry signal was received at Cape Canaveral which indicated that the heat shield could possibly be detached from the spacecraft. After careful consideration for a period of about 10 minutes subsequent to the passage of the spacecraft, I determined that the chances were about 95 percent that the telemetry signal was the result of a faulty electrical switch in the spacecraft. At this time I informed the group of engineers which was located at the Mercury control center for the purpose of assisting me on technical matters. My direction to them was to consider all possible causes of this malfunctioning electrical switch and to recommend what procedures should be used prior to reentry. It was decided to corroborate this telemetry signal using information from other stations in the range-tracking network. A check of several stations substantiated

the information received at Cape Canaveral. I also decided not to inform Astronaut Glenn of this situation until it became absolutely necessary.

As *Friendship 7* started its third orbit, it became apparent that a decision would have to be made prior to the end of that orbit. The situation was as follows:

(a) If the signal was as a result of a faulty electrical switch, the retropackage could have been jettisoned after retrofiring as is the normal procedure.

(b) If the heat shield were in fact loose, the jettisoning of the retropackage would allow the heat shield to become displaced from its normal position and the resulting reentry heating would have destroyed the spacecraft.

(c) If the retropackage were retained after retrofiring, the resulting reentry, as determined by previous wind tunnel tests, would have been slightly more dangerous than a reentry with an unobstructed heat shield.

After consulting with the aforementioned group of engineers, as well as considering recommendations from the McDonnell Aircraft Co. representative, it was decided by myself and Mr. Walter C. Williams and Mr. C. C. Kraft that the retropackage should be retained after retrofiring to insure that a catastrophic reentry did not occur. In this case, as has been described by the news media, a successful reentry was made.

Astronaut Glenn, having been informed of the situation prior to reentry, intuitively realized that this departure from the planned flight program had been made only after careful consideration. His procedure, therefore, was to follow our recommendations exactly.

Since the flight it has been determined that the radio telemetry signal was the result of a faulty microswitch in the spacecraft. This condition will be corrected and new switches will be installed in all future spacecraft.

The situation as described in this statement is an example of the careful attention to detail, the dedicated effort applied to preflight studies, and the subsequent decisions which can be reached as a result of the efforts of the Project Mercury team. It is only through this type of research and study that the NASA can continue to make space flights with the highest order of success.

Senator YOUNG. Thank you.

Mr. Chairman, I have no further questions.

The CHAIRMAN. Thank you, Senator Young.

Was that the part of your experience that caused you to refer to the capsule or the trip as being a fireball, or something of that kind?

"MAN, WHAT A FIREBALL"

Colonel GLENN. Mr. Chairman, during the reentry as the heat shield operates back there, the surface ablates away. It goes into sort of a steamball almost, and absorbs heat. As this heated material ablates away from the shield and comes around the capsule, it is still very hot, it is glowing, and you can look out the window and you can see you are actually in the middle of a fireball during reentry. It is an orange glow. That was when I made the remark about, "Man, what a fireball," or something to that effect.

The CHAIRMAN. Senator Cannon.

COLONEL GLENN IS A HERO TO AMERICAN YOUTH

Senator CANNON. Thank you, Mr. Chairman.

I want to join with the others here in congratulating you, Colonel Glenn, and the entire team, the astronauts, the director of the program, and the thousands of people who worked on this project to make it a success, and help get America back into the position that they should be in the world, and I believe they are today.

In that connection, I think one of our great military leaders made a very good observation to me yesterday when he said that he was extremely happy to see that the idol and the hero of the American teen-

ager and youth today had changed from the rock and roller to Col. John Glenn. I think that is extremely important.

GOOD PHYSICAL CONDITION IS NECESSARY

In that connection, I would like to direct a question to Captain Grissom, who explained the importance of this training program.

I would like for you, if you would, sir, to emphasize the importance of physical fitness to anyone who intends to operate in this type of a program. I think it is important for the public to know that you men, at the time you started your training program, were in need of additional physical conditioning to carry out the program successfully, if it is a fact.

Captain GRISSOM. Being in the military and especially in test flying, I think that all of us probably were in better physical condition than other men of our age throughout the country. But we have found that it is necessary to stay in good physical condition just to undergo the training program, let alone the flight, and by being in good shape, we feel that we are ready for any emergency or any contingency that should occur. We do feel it is very important. We don't have a formalized physical training program. Each of us goes at our own pace and just makes certain that each of us stays in condition.

Senator CANNON. Colonel Glenn stated that it was extremely important as a prerequisite for anyone desiring to get into this overall program that they have a basic, good, general education. Would you say also that it is an important prerequisite that they maintain themselves in good physical condition?

Captain GRISSOM. Yes. I think this is important to all of the youth of our country, to maintain themselves in good physical condition.

I would like to say something else about the basic education that John talked about. I have always had the feeling that—and I have told all the young people that have written to me—I think they should follow their own interests. This keeps them happier, they do a better job, and then it is up to us to lead them a little bit and make sure their interests are where they should be.

Senator CANNON. Thank you, Captain Grissom.

Colonel Glenn, with further reference to your prerequisite of a basic, good, general education, as we know there were thousands of scientists and scientifically trained personnel working on this program. I wonder if you would care to comment on the importance to a program of this nature of the specialized, specially trained personnel in the scientific and engineering field?

WITHOUT SCIENTISTS AND ENGINEERS, THERE WOULD BE NO SPACE PROGRAM

Colonel GLENN. Yes, sir, Senator; I would like to comment on that very much. Without such people, there would not be any program such as this. We have been receiving, the three of us here, and the other fellows that were here the other day, have been receiving all the acclaim, of course, for all of the efforts that have gone into this program. Actually, we are more figureheads than anything else. We are not trying to underplay the fact that we are the people in the

capsule and we have our necks out, of course, where the other people don't. We don't deny that at all. But beyond that point, we are merely figureheads. We are representatives for a tremendous pyramid of technical and scientific work that is hard to believe until you are actually involved in the program. We are really the representatives for all those people during all this acclaim, and that is actually the way we feel about it. We are not just paying lipservice to that. It is a big, hardworking team altogether, and it has been that way all the way through.

MORE CAN BE GAINED FROM EXPERIMENTS WITH A MAN ABOARD

Senator CANNON: Colonel, you said that one of the most important things you discovered was that man can satisfactorily operate in space, and you also pointed out that this particular shot might have failed had it not been for a man being aboard, because of the failure of part of the system. As you know, there has been a considerable argument going on as to whether man can better perform missions in space and outer space than a machine. Would it be fair to assume, from your experience here, that we are not at a technical state today where man can satisfactorily be replaced in space or in the atmosphere for the performance of missions by machines in our present state of technological development?

Colonel GLENN: I feel, sir, that we are already at the point where we can gain far more from the experiments we want to carry out by having a man aboard. Early in the program, we could get as much probably at one time on certain early experiments by making just an instrumented machine and sending it up and back. But we are looking forward to the time when we will have power sufficient to go out and actually stay in space for extended periods of time, make extended observations, conduct scientific experiments that will be fairly complicated. If we have power sufficient at that time, of course, we will want to maybe change course, drive around in your spacecraft as you do now in an airplane, for instance, and go where you want to go to do and see and make the observations that are best to be made. Looking forward to that time where an intelligent human being in space is mandatory, there are some things that we can never foresee doing with machines; looking forward to that time when we are not as power limited as we are now, at that time we can go out into space with a man aboard and make tremendous advancements, where, if you have to program all of this in advance and send it out on a specific mission and back, you have no flexibility at all. I think we are at the point now where we can foresee in the future powerplants that will enable us to do a lot of these things.

Perhaps some of the other fellows would like to make comments on that.

The CHAIRMAN: Commander?

MAN IS AN EFFECTIVE AND RELIABLE "COMPUTER" IF PROPERLY TRAINED

Commander SHEPARD: If I might, I would like to add a few words to what John has just said.

I think you cannot categorically say that man should be in every space vehicle. Obviously, there are conditions where you are investi-

gating a specific area, for example, radiation belts, or you are investigating a particular communications phenomena, as is being discussed in the committee at this time, as I understand it, where decisions with regard to what you want can be made on the ground ahead of time. I think in these areas, machines, electronic devices, do far better than the man does.

However, the human is a computer, really, and if you train the human properly then the computer can work more effectively per pound than any mechanical computer that we have. A man's decisionmaking process is obviously slower but it is a fairly reliable thing under the proper conditions of training. So I would like to add these remarks to what John has said.

Colonel GLENN: I might carry that one step further. I have heard the saying that he can also be produced cheaply and easily.

Senator CANNON: I suppose as pilots, all three of you would agree that the days of the pilot are not completely over?

Colonel GLENN: No, sir.

Captain GRISSOM: Amen.

G. FORCES VARY WITH REENTRY ANGLE

Senator CANNON: I believe, Colonel Glenn, you sustained less g. forces on reentry than Commander Shepard. Was that because of the angle of reentry?

Colonel GLENN: Yes, sir; it was. The angle of reentry was completely different on the two type missions. On the Friendship 7 flight we came back in on about a 1.8 degree angle to the atmosphere. On the earlier flights, the Redstones, these reenter the atmosphere at a much steeper angle, take their g. pulse in a much more compounded period. On mine it was at a lower peak, about 8 g.'s, but extended over a longer period of time. So there are different trajectories.

Senator CANNON: Thank you very much.

Thank you, Mr. Chairman.

The CHAIRMAN: Thank you very much, Senator Cannon.

I would like to observe that his questions with reference to the requirements for, the use of, and the desirability of pilots and our continuing need of them and respect of them not necessarily was directed solely to the position of the witnesses.

If I am not mistaken, the Senator from Nevada is, himself, a very high ranking officer in the Air Force Reserve and has quite a distinguished record as a pilot. I believe he may be even a test pilot for jet aircraft.

I am sure that there are Members of the Senate and the House who would hope that these witnesses would confine their activities for the foreseeable future to those directly connected with their profession rather than following the example of the great pilot from Nevada who permitted himself to be detoured or averted into politics.

Senator CANNON: I thank the Chairman for overstating the case.

The CHAIRMAN: The Senator from Florida, Mr. Holland.

87TH CONGRESS

SENATE

DOCUMENT

1st Session

FLORIDA HAS BEEN FINE HOST TO SPACE PROGRAM

Senator HOLLAND. Thank you, Mr. Chairman.

Mr. Chairman, the people of my State are humbly proud that for reasons not having to do with them at all, largely depending upon the geography of the State, the climate of the State, that we are the host State for much of this activity. We would like to think, however, that as human beings we have made the maximum contribution possible by way of consideration and assistance. With that in view, I would like to ask these gentlemen if they have any suggestions—and I want them to be frank; the people of Cape Canaveral, Pensacola, Key West, and of the whole State want them to be—have you any suggestions as to how our people might be more helpful, more cooperative, more active in their assistance as the host areas in which this activity is carried on?

First, Colonel Glenn.

Colonel GLENN. Gus?

Captain GRISSOM. No, sir; none that I can think of, sir. We have always been treated in very fine fashion in the Cape Canaveral area where we have done most of our work in Florida, of course. We have been over to Pensacola a number of times. It is always a pleasure to work in Florida. The weather is very nice there this time of year, Senator.

Senator HOLLAND. I meant what I said. Our people would want me to make it clear that they would like to make contributions which would be the maximum possible from the host areas.

MANUAL CONTROLS DETERMINE ATTITUDE OF CAPSULE

I want to ask you one more question, Colonel, which is asked because of some letters I have had and some comments. I think that there is a misapprehension abroad on the part of many of our people that manual controls permit the space traveler to go as he wishes while he is in space, whereas my understanding is, and I think this is a fact, that the orbit is fixed, and the manual control, until time of reentry comes, can only have to do with the posture or attitude of the capsule. Is that correct?

Colonel GLENN. That is correct. You have stated it properly. Once we are fixed in orbit, then that trajectory, that orbital path remains the same. We have attitude control within the capsule, along this trajectory. We can control the direction that the capsule is headed. We don't have sufficient power on board the capsule to actually alter its flight path. When I speak of maneuvering in the future in space, we certainly hope that we can eventually have powerplants that will enable us to do both, to not only maintain attitude control as we do now, but also have power sufficient, which, incidentally, requires tremendously increased power over that required just for attitude control, of course, to go ahead and actually change orbit or to leave one orbit and go to another orbit around the moon and back again. I think eventually we will come to the day when this is possible. This is the time we are looking for when man will really take his real, rightful place in space.

MARCH IN TIME, MAN WILL CONTROL ORBIT AROUND

Senator HOLLAND. You hope, then, for the time to come when the man inside can direct the course, the orbit, in which the capsule will travel?

Colonel GLENN. Yes, sir.

Senator HOLLAND. Thank you, Mr. Chairman.

Mr. WEBB. Mr. Chairman, before we conclude, could I say that I have a friend at the press table who has suggested that Colonel Glenn say a word about what the stars really look like—that this is a real new element! There is much that can be said.

The CHAIRMAN. If you will wait a minute, we will do that.

Senator Magnuson, a distinguished member of this committee, could not be here. He was very anxious to have two questions asked. He asked Senator Pastore, chairman of the Subcommittee on Communications of the Commerce Committee to be here.

Would you ask those two questions for Senator Magnuson, Senator Pastore?

Senator PASTORE. Yes; I will be very glad to. First let me say that I consider this a privilege to be here on this occasion, and I join with my colleagues in the very fine tribute and deserved tribute they have paid to these three excellent Americans.

The question is this, and then I have one question of my own; which I hope that the chairman will indulge me in asking.

ASTRONAUTS HAVE HELPED WITH COCKPIT MOCKUP FOR DYNA-SOAR

Mr. Magnuson's question is this: Are there any plans to make your experience available to the Air Force and its industrial contractors to improve the design of the cockpit and the spacecraft in the DYNA-SOAR and other military space programs?

I don't know whether that is a question to Mr. Glenn.

Colonel GLENN. I think perhaps I should defer that question to Gus Grissom, since he has already been out doing some of that liaison work.

Captain Grissom. I think John actually already answered the question. Everything we have done is available to the Air Force or any of the other contractors that should desire it. We have been working with them to a limited extent, at least, on their cockpit mock up, and we hope to continue this in the future. We also hope that the DYNA-SOAR pilots and the DYNA-SOAR people will participate some in our program so that there is some exchange of ideas and improve both programs.

Senator PASTORE. Now, Mr. Chairman, may I ask my question on my own?

The CHAIRMAN. Yes.

OPEN COVERAGE WAS A WISE DECISION

Senator PASTORE. Some reference has been made here this morning that we are living in an open society. I recall that in much of our activity in the past there has been some criticism on the part of very

few, fortunately very few, that we always operate in the open; we have the habit of telling all.

Now, in this particular instance, the entire world was given the opportunity to see you, Mr. Glenn, go up and to come down. In that way, of course, we dramatize our failures as well as we sometimes dramatize our successes. Is this a good way of doing it?

Colonel GLENN. Well, I say quite frankly that there were some of us, when it was decided that we were going to have complete coverage at the Cape, that heard this with some misgivings. We felt at that time with no flights behind us, and the Russians having had a successful flight at that time, that perhaps this was not wise, for the exact reason you stated; it would dramatize our failure and make us look even worse before the world at that time. The decision was made that we would go ahead in the open presentation of all the flights, open to the news media of the world. This obviously was a wise decision, I think, looking back on it now. It has placed us in our traditionally American position of being open, free, and honest with all the countries around the world, where otherwise we might have been criticized for holding back and for looking like some other societies have done, where they have closed doors on such things as this.

"THERE WILL BE SOME FAILURES"

This points up another thing, though, that we talked about some yesterday among ourselves, well, and in the open, too, and that is we may have failures sometime in the future. We are sort of riding the crest of success here at the moment, but as in aviation there will be failures sometime. We are certainly not looking forward to these, we are not planning on them, but being realistic, we know they will occur. Anytime you have this type of motion, this much machinery and these kinds of speeds involved, sometimes there will be failures. We hope that the confidence and the kind of feeling we share or we have in this program and in its tremendous future, the enthusiasm will not be dimmed for the final objectives we are after at that time.

The CHAIRMAN. Thank you very much, Colonel.

Mr. Webb?

NASA HAS CLOSE COOPERATION WITH THE MILITARY SERVICES

Mr. WEBB. Before I suggest that Colonel Glenn speak about how the stars really looked, since this is the first look an American has had at them from outer space, I would like to comment on the question asked about cooperation with our military services. We have a complete system of cooperation not only for the astronauts who give their specific flight experience and work on such matters as have been mentioned; namely, cockpit design and other such matters, but we have a very complete system of exchange. This is a national space program. Our launch vehicles are built and operated under a national launch vehicle program. When we come to build a two-man spacecraft, the GEMINI, it is entirely possible that the military services may have some need for this. In the DYNA-SOAR program, in which they are

very much interested, we have a very close cooperation, and in many areas, such as the flights of the X-15, we gained common experience by common operations. Some of our men and some of the Air Force men worked with the X-15, some of our pilots fly missions, some of their pilots fly missions, but the United States has the benefit of the total of this knowledge for all the agencies that need it.

Now as to the stars, if you can say anything, John.

COLONEL GLENN DESCRIBES HIS VIEW OF STARS

Colonel GLENN. A comment on the question regarding the stars: I was rather surprised that you could not see more stars, even on the night side as well as the day side, that the question was directed to. I think it is more like being out on the desert on a very clear, dark summer night, when you can look up and the stars just seem to jump right out at you. They are very, very bright. I think they look very much like that, and I could not see them in any increased quantities, particularly.

Probably a lot of this is due to the fact that the particular window we have on the spacecraft cuts down the light in about the same quantity as the atmosphere that we normally look through on a summer night. So this means even in space with the window we have right now, we won't see too much more in the way of stars.

Now, the light was very steady, it didn't blink on and off, you didn't see twinkling of the stars. It appeared to be a very steady light. On the day side, which is the period of time the question was directed to, you could not see stars as long as I had the capsule down in the attitudes where I was looking out the window toward the horizon. When I glanced from that up to the dark areas of space, I still could not immediately see stars. However, if I would come up with the small end of the capsule above the horizon, and night adapt my eyes for a minute or so, I could begin to see the stronger stars, the higher magnitude stars, becoming visible. We had planned to make a number of observations on the last two orbits along this line. However, since we had some small control system difficulties, I was concentrating mainly on those during the last two orbits and didn't really get some of these observations that we would have liked to have made. I hope that answers the question.

The CHAIRMAN. Could you indulge us about 2 more minutes, Mr. Webb?

Mr. WEBB. Yes, sir.

The CHAIRMAN. The Senator from Missouri who very graciously, a while ago, waived his time has a question or two he would like to ask.

Senator SYMINGTON. Thank you, Mr. Chairman.

LONGER FLIGHTS MIGHT PRODUCE ILLNESS

Colonel Glenn, I am impressed by your saying there may be problems in the future. As the great flyer you are, you know that is true. You mention the question of illness. It might be possible, might it not, for the human body to be affected by a longer flight than the one you made?

Colonel GLENN. Yes, sir; very much. We are only basing our statements today on our flight experience up to date. That has been

tracking station at 37 minutes after the hour; that is 11:37 a.m.

about 4 hours and 57 minutes. Longer flights might well give some effects we don't now see.

Senator SYMINGTON. That might be one of the reasons why, as we overcome the lead of the Russians the President mentioned, the Russian got ill, might it not—the longer flight?

Colonel GLENN. It could be. That would be possible, of course.

RADIATION PROTECTION BEING PLANNED FOR APOLLO SPACECRAFT

Senator SYMINGTON. One other question to you. What plans are we making now to overcome the problems incident to radiation in the Van Allen belt, as we move out toward the moon?

Colonel GLENN. That is a difficult one, and one that I probably should not comment on because I haven't really studied this thoroughly enough with the proper people. I think Al has been talking more to them recently about this. I have been pretty well tied up the last few months, as you can imagine.

Senator SYMINGTON. He is the one who interested me in the problem.

Colonel GLENN. Would you care to comment on that, Al?

Commander SHEPARD. We said a great many things in the airplane the other day, Senator, but I am not sure I covered this point.

The reason I asked to make a few comments was because I had the opportunity to be in on the design stage of APOLLO, that is, in our basic letter to the contractor. I will say only generally that APOLLO is the first program during which we expect to encounter higher levels of radiation, specifically the Van Allen belt. The plans here are made for radiation protection within the structure of the command vehicle. That is, the vehicle which houses the crew, so that we will have some integral protection; and then during periods of passage through the Van Allen belt, at which time we feel radiation levels will be inordinately higher, then some type of equipment which can be donned for that purpose will be provided, a suit, a bullet-proof vest type of thing maybe, will be provided for use during these periods and can be taken off to provide more mobility at other periods during the flight. That is the general plan.

Senator SYMINGTON. Thank you.

ADMINISTRATOR WEBB FEELS THE SPACE PROGRAM IS EFFECTIVELY ORGANIZED

Mr. Chairman, I inadvertently omitted high praise so well due to Dr. Hugh Dryden, an old friend. I would like to associate myself with the remarks made about him by my colleague, Senator Stennis.

Mr. Webb, I ask you this question. You have held many high offices in the Government, assistant to the Under Secretary of the Treasury, Director of the Bureau of the Budget, you have been Under Secretary of State, and a successful businessman. You know the importance of eliminating waste in private operations and in Government operations. With that background, do you believe you have drained all possible waste out of the great new appropriation request you come before this committee to ask for?

Mr. Webb. Yes, sir. I am having no problems at

I thought this would be a good time to have you on the record.

Mr. WEBB. That is a little bit like asking you if you have stopped beating your wife. Actually, these programs have to be carried forward very rapidly. The policy announced by the President was not to carry them on as crash programs involving some of the kind of waste that I believe you have in mind. But they are very rapidly paced programs. As we have studied the capacity we have to extrapolate the knowledge we have and the technology we have to make the lunar landing and develop the APOLLO system, which includes the boosters and the rendezvous technique, we know that there are certain expectations we have which will not be realized. At that time, we have to make a substitution of a new way around the obstacle. At that time, we may start one or two or three possible developments on a specific item, so that the whole project can go forward without delay. I do not regard that as waste.

I think I could say that in this whole team effort, which includes not only the National Aeronautics and Space Administration, but all of the armed services, particularly the wonderful support we have had from the Navy in our recovery operations and the great support we have had from other nations in these; tracking and data acquisition, I can say I have never seen a program as large as this, carried on more effectively, with more able men and women involved in it. I think the greatest assurance that you can have that you will get your money's worth is in the opportunities in this great new area of space, plus the quality of the men and women.

I would like to add one thing. Dr. Dryden and I have given a great deal of care and attention to how we organize this, bearing in mind that the President has announced the policy we must use the resources of the country where they are and not duplicate them, whatever resources are in the Atomic Energy Commission, the armed services or the other areas we are to use. Bearing that policy in mind, I should say we have a very effective form of organization, with four program planners handling the budget and being directly, personally responsible for the effectiveness of their program, using resources wherever they may be. I think the form of organization, the quality of the people, and the opportunities ahead will make this one of the best investments the United States has ever made.

Senator SYMINGTON. Thank you, Mr. Chairman.

AIR FORCE COOPERATION HAS BEEN OUTSTANDING

Mr. WEBB. Dr. Dryden reminds me to mention Air Force cooperation. This has been also outstanding. As you know, in the rendezvous technique, the Air Force is just as interested from the military standpoint as we are from the standpoint of the lunar approach. We are working closely and intimately on this.

When we look for an engine in space to rendezvous with, it will be an engine that the Air Force put up. So we will have the closest association and will share commonly in the knowledge that is gained from this.

The CHAIRMAN. Thank you very much, Mr. Webb, and the special thanks of our committee to you and Dr. Dryden, Mr. Gilruth, Colonel Glenn, Captain Grissom, and Commander Shepard.

I wonder if the audience will remain seated until these gentlemen have retired.

I must acknowledge the fact that our distinguished colleague from New York, Senator Keating, is with us; from North Carolina, Senator Everett Jordan; and I also see the distinguished Senator from Kentucky, Mr. Cooper.

Now if the audience will remain seated until the astronauts and Mr Webb have retired, then the committee will go back into session on the communications satellite bill.

Dr. Engstrom will return to the witness stand for questions.

Mr. WEBB. Thank you, Mr. Chairman.

(Whereupon, at 11:25 a.m., the committee proceeded to other business.)

Flight path is good. Roger. Checks OK. Coming up here now. Roger. Coming into high gear a little bit. A little bit more window, or something. Roger.

102 101. Oxygen 78, 100. Amps 2.4 still OK. We are out some now, getting out of the Western area. Roger. Flight path is very good. Pitch 4.4. Coming out real nice. Flight very smooth now. Roger. Flight path is good.

Cabin pressure is holding at 6.1 OK. Roger. Cabin pressure holding at 6.1. Roger.

Have had some difficulty that may seem to be damped. The air is still in the 100. 101 oxygen 78, 102. G's are holding.

Flight path looks good. Pitch 2.5. Roger.

101 102. I see the tower go. I saw the tower go. Roger.

Roger. We are still on PM. Roger. Still have about one and a half G's. Roger. Over.

* * * the tower went right then. I have the tower in sight way out. Roger. We confirm on PM. * * * tower is green.

One and a half G's. Roger; loud and clear; flight path looks good. Retro jetison. Emergency retro jetison slips off * * *

Flight path looks good. Steering is good. Roger. Understand everything looks good.

G's are holding well. Pitch 0.1. Roger.

Roger. This is Friendship 7. Fuel 103 101. Reading above 2.5 amps 2.6. Roger. Reading above 2.5 amps. Flight path looks good. Pitch minus 3.

7.7 on your minus 3. Roger. 7.7.

Oxygen 78, 100. Amps 2.5. Cabin pressure holding at 2.5. Roger. Reading you loud and clear. Caps is "Go." We are ready for you.

Roger. Caps is "Go" and I am "Go." I am in good shape. Roger.

All systems OK. Oxygen 78, 100; cabin pressure holding steady at 2.5. Amps 2.5. Caps are "Go." Roger. 20 seconds.

Flight path looks good. Roger. 20 seconds. Flight path looks good. Roger.

SECO (Solid Rocket Motor) cut-off * * * grade fired ok. Roger. Stand by.

APPENDIX D

PUBLIC ADDRESS ANNOUNCEMENTS BY COL. JOHN POWERS BEGIN- NING AT T MINUS 22 MINUTES DESCENDING MA-6 LAUNCH

0900—T minus 22 minutes and holding. We have encountered some difficulty in the ground support equipment valve in the liquid loading system, T minus 22 minutes and holding.

0910—T minus 22 minutes and holding. We have reconsidered difficulty with the liquid oxygen loading valve out in the launch pad area. We are at T minus 22 and holding, and we estimate at this time an additional 10 minutes.

APPENDIXES

0925—The MA-6 launch countdown is just resumed. We are at T minus 22 minutes and holding. The MA-6 launch countdown is proceeding and we are at T minus 22 minutes and counting.

0927—The MA-6 launch countdown is at T minus 20 minutes and counting. The MA-6 countdown is at T minus 20 minutes and counting.

APPENDIX A

BASIC STATISTICS OF COLONEL GLENN'S FLIGHT

Date: February 20, 1962.

Nature of flight: Earth orbit.

Number of orbits: 3.

Altitude (miles) perigee: 99-100.

Altitude (miles) apogee: 162.

Period: 88 minutes.

Distance (miles): About 81,000.

Top speed (estimated, in miles per hour): 17,545.

Flight time: 4 hours 55 minutes.

Weight of craft (pounds): 4,265 (at launch).

Craft name: Friendship 7.

Rocket thrust (estimated, in pounds): 360,000.

Weightlessness: About 4 hours, 40 minutes.

The MA-6 vehicle is in condition to support the mission.

33

0930—The MA-6 launch countdown is at T minus 18 minutes and counting; this is Mercury Control.

0935—The MA-6 launch countdown is at T minus 15 minutes and counting.

0940—The MA-6 launch countdown is at T minus 12 minutes and counting.

0945—The MA-6 launch countdown is at T minus 9 minutes and counting. All systems are reported in a "Go" position. John Glenn is ready. This is Mercury Control, T minus 30 and counting. The Mercury space capsule umbilical is out. We are at T minus 19 seconds. T minus 19 seconds, 8, 7, 6, 5, 4, 3, 2, 1, 0, ignition, lift-off. The MA-6 vehicle has lifted off; projectile looks good. The MA-6 is off the launch pad at 47 minutes after the hour; it is climbing nicely; all systems are reported "Go."

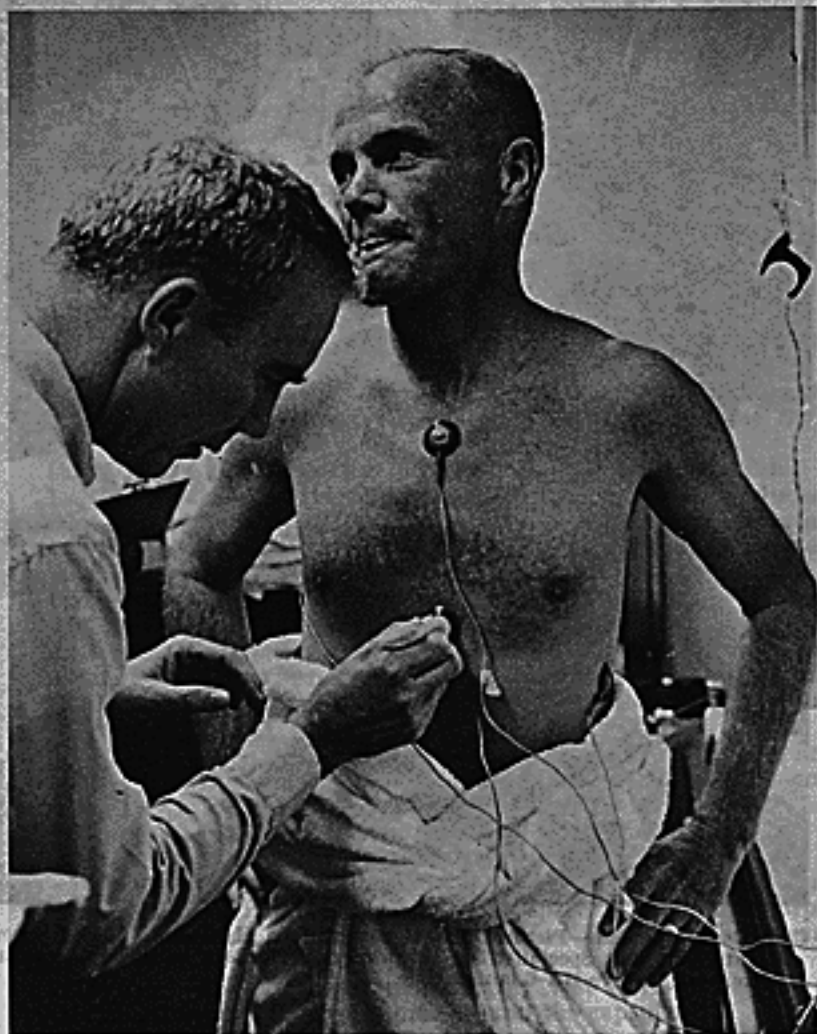
The MA-6 vehicle is climbing freely. The trajectory is going OK; the MA-6 vehicle is still climbing nicely. It has passed through the

12:15 p.m.—Contact with Woomera, Australia, station. Astronaut reports some difficulty maintaining attitude with the manual control system. Otherwise, everything "normal."

12:41 p.m.—Contact at Canton Island reports contact.

APPENDIX B

PHOTOGRAPHS OF COLONEL GLENN AND FRIENDSHIP 7 CAPSULE

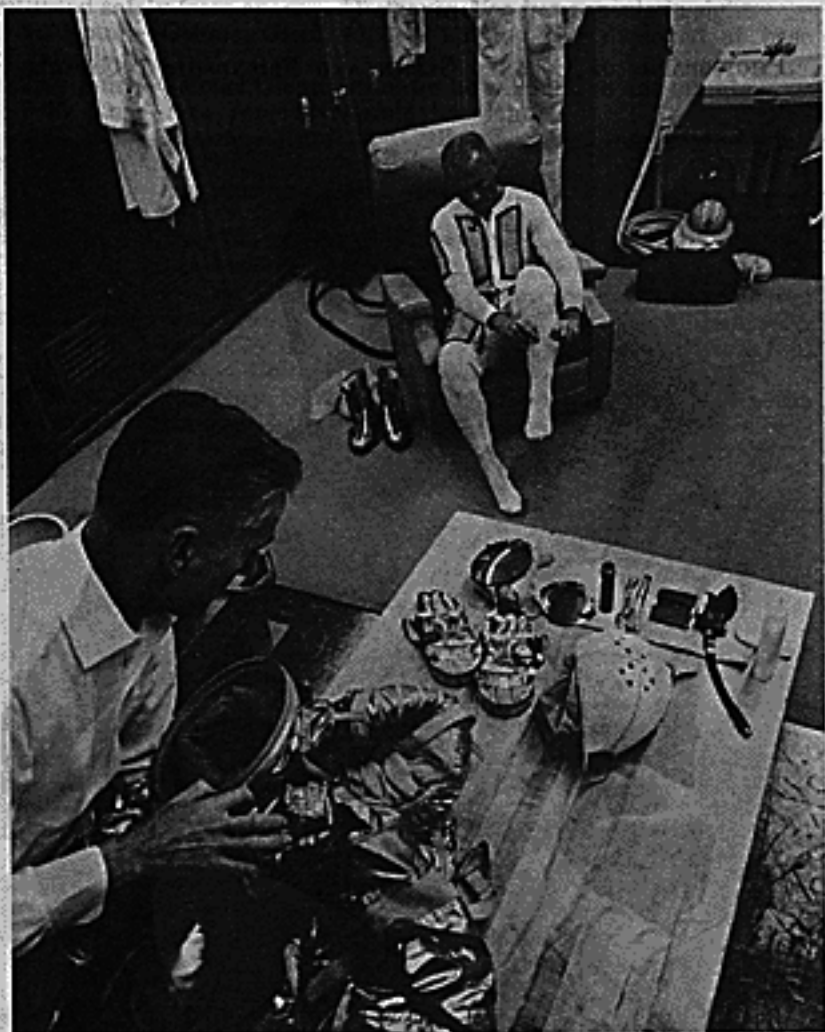


Cape Canaveral, Fla.—Astronaut John H. Glenn, Jr., undergoes last-minute medical checks before MA-6 launch.

2:35 p.m.—Voice communication reestablished. "Boy it was a real trip!"

2:27 p.m.—Drogue parachute deployed at 21,000 feet to steady the capsule.

2:38 p.m.—Main parachute deployed. "He is obviously an elated pilot," reports Mercury control center. — Colonel Glenn seems to have



Cape Canaveral, Fla.—Pictured are Astronaut John H. Glenn, Jr., and Space Flight Equipment Specialist Joe W. Schmitt performing suiting-up preparations shortly before MA-6 launch time.

Cape Canaveral, Fla.—Astronaut John H. Glenn, Jr., and Space Flight Equipment Specialist Joe W. Schmitt performing suiting-up preparations shortly before MA-6 launch time.



Cape Canaveral, Fla.—Astronaut John H. Glenn, Jr., adjusts helmet prior to MA-6 launch.

- 7:48 a.m.—Large patches of blue sky appearing.
- 7:53 a.m.—Broken belt has been removed and hatch has been replaced.
- 8:05 a.m.—The countdown is resumed at T minus 60.
- 8:20 a.m.—A hold is ordered at T minus 45 minutes while ten gallons of fuel is added. The red gantry tower starts rolling back.
- 8:35 a.m.—The count is resumed at T minus 35 minutes.

8:40 a.m.—The liquid oxygen starts flowing out of the rocket. This is the crucial last phase of the countdown. Orange-jacketed Marines start climbing into their rescue helicopters at the Forward Medical Area.

8:55 a.m.—T minus 25 and counting. All systems appear OK.



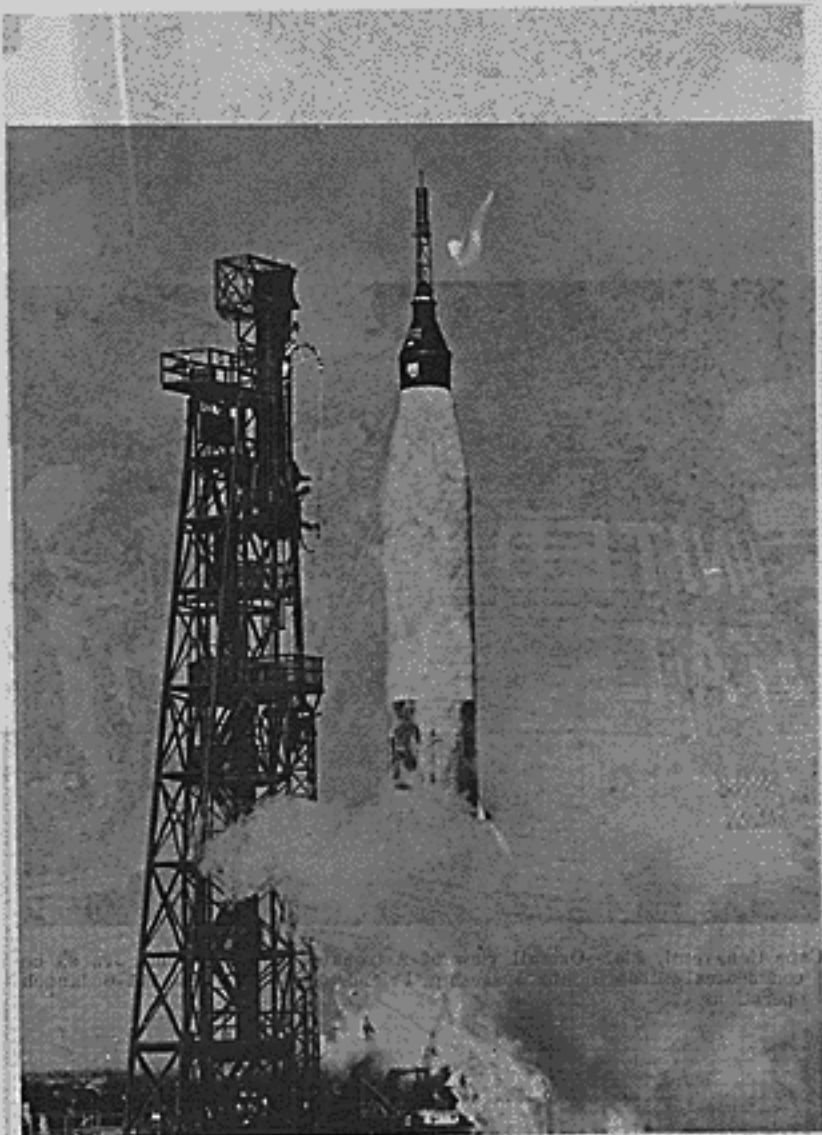
01 Cape Canaveral, Fla.—Astronaut John H. Glenn, Jr., in spacesuit beside Mercury-Atlas 6 spacecraft "Friendship 7."

12:01 p.m.—Makes second contact with Indian Ocean tracking ship. Colonel Glenn's condition remains good.

12:10 p.m.—Talks with astronaut Cooper again at the station in Murchie, Australia.



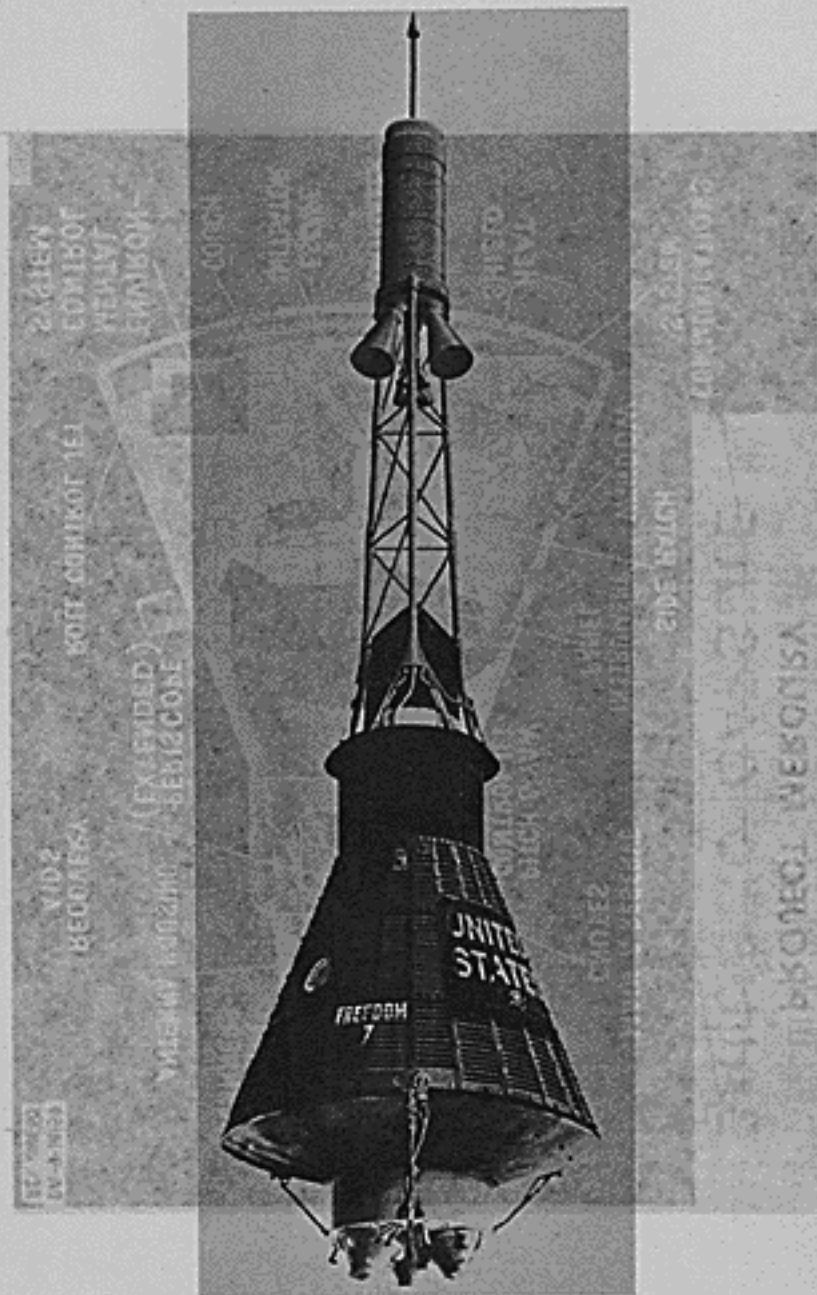
Cape Canaveral, Fla.—Overall view of Astronaut John H. Glenn, Jr., as he commences entrance into spaceship Friendship 7 prior to MA-8 launch operations.



Cape Canaveral, Fla.—View of NASA Manned Spacecraft Center's Mercury-Atlas 6 carrying Friendship 7 spacecraft with Astronaut John H. Glenn, Jr., on first U.S. orbital flight.

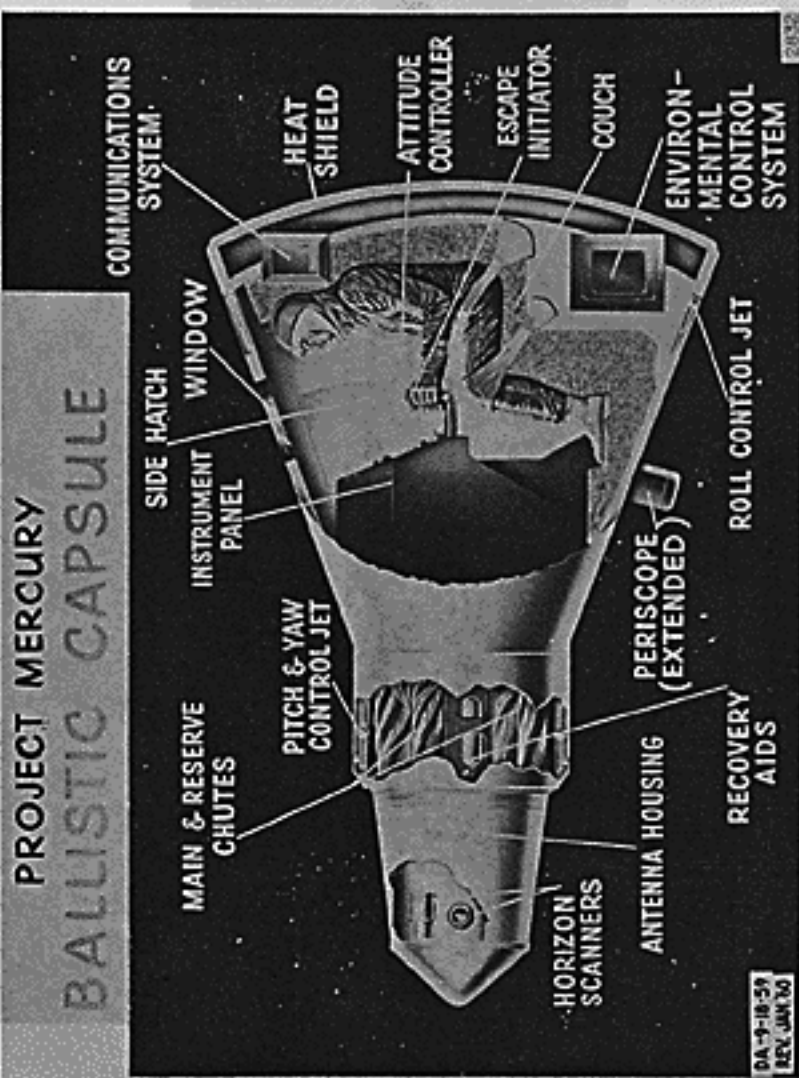
- | | | |
|-------------------|----------------|----------------|
| 1. Cape Canaveral | 2. Launch Pad | 3. Launch Pad |
| 4. Launch Pad | 5. Launch Pad | 6. Launch Pad |
| 7. Launch Pad | 8. Launch Pad | 9. Launch Pad |
| 10. Launch Pad | 11. Launch Pad | 12. Launch Pad |
| 13. Launch Pad | 14. Launch Pad | 15. Launch Pad |
| 16. Launch Pad | 17. Launch Pad | 18. Launch Pad |
| 19. Launch Pad | 20. Launch Pad | 21. Launch Pad |
| 22. Launch Pad | 23. Launch Pad | 24. Launch Pad |
| 25. Launch Pad | 26. Launch Pad | 27. Launch Pad |
| 28. Launch Pad | 29. Launch Pad | 30. Launch Pad |
| 31. Launch Pad | 32. Launch Pad | 33. Launch Pad |
| 34. Launch Pad | 35. Launch Pad | 36. Launch Pad |
| 37. Launch Pad | 38. Launch Pad | 39. Launch Pad |
| 40. Launch Pad | 41. Launch Pad | 42. Launch Pad |
| 43. Launch Pad | 44. Launch Pad | 45. Launch Pad |
| 46. Launch Pad | 47. Launch Pad | 48. Launch Pad |
| 49. Launch Pad | 50. Launch Pad | 51. Launch Pad |
| 52. Launch Pad | 53. Launch Pad | 54. Launch Pad |
| 55. Launch Pad | 56. Launch Pad | 57. Launch Pad |
| 58. Launch Pad | 59. Launch Pad | 60. Launch Pad |
| 61. Launch Pad | 62. Launch Pad | 63. Launch Pad |
| 64. Launch Pad | 65. Launch Pad | 66. Launch Pad |
| 67. Launch Pad | 68. Launch Pad | 69. Launch Pad |
| 70. Launch Pad | 71. Launch Pad | 72. Launch Pad |
| 73. Launch Pad | 74. Launch Pad | 75. Launch Pad |
| 76. Launch Pad | 77. Launch Pad | 78. Launch Pad |
| 79. Launch Pad | 80. Launch Pad | 81. Launch Pad |
| 82. Launch Pad | 83. Launch Pad | 84. Launch Pad |
| 85. Launch Pad | 86. Launch Pad | 87. Launch Pad |
| 88. Launch Pad | 89. Launch Pad | 90. Launch Pad |
| 91. Launch Pad | 92. Launch Pad | 93. Launch Pad |
| 94. Launch Pad | 95. Launch Pad | 96. Launch Pad |
| 97. Launch Pad | 98. Launch Pad | 99. Launch Pad |
| 100. Launch Pad | | |

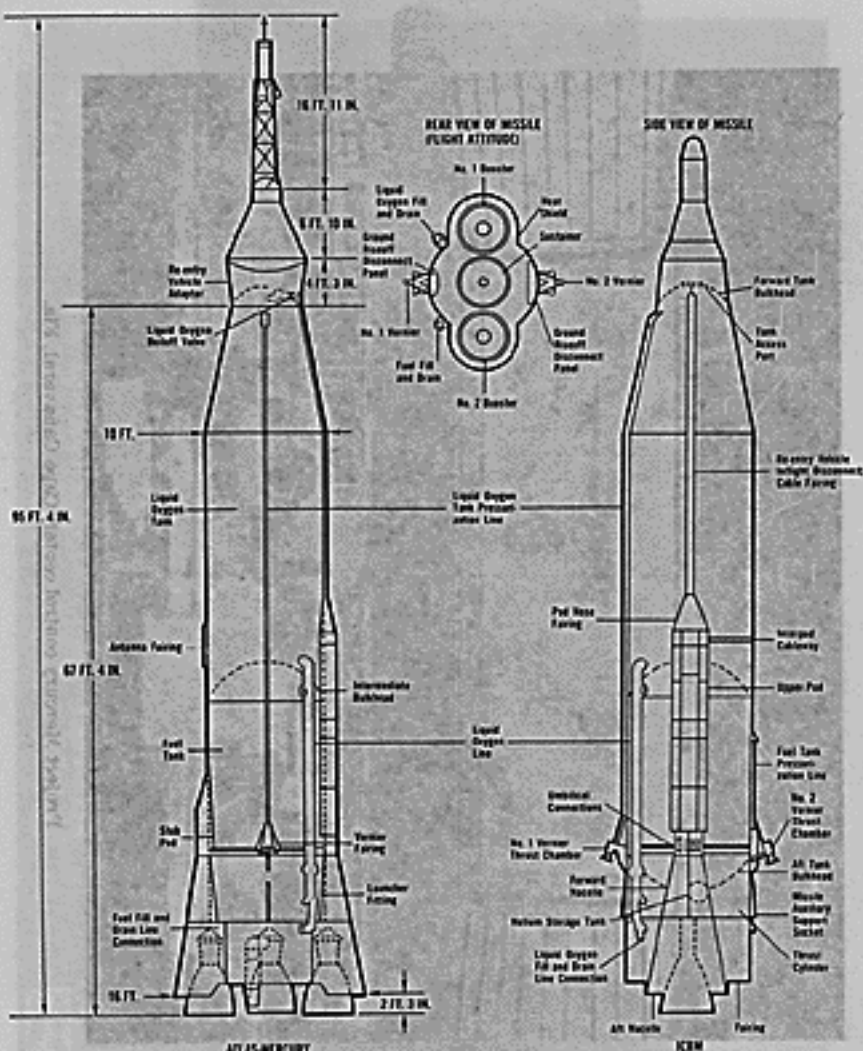
World map showing the three earth orbits of the Mercury-Atlas 6 launch, plus the 13 Mercury ground stations around the world.



Commander Shepard's Mercury capsule Freedom 7 (Note straps holding retrorocket package).

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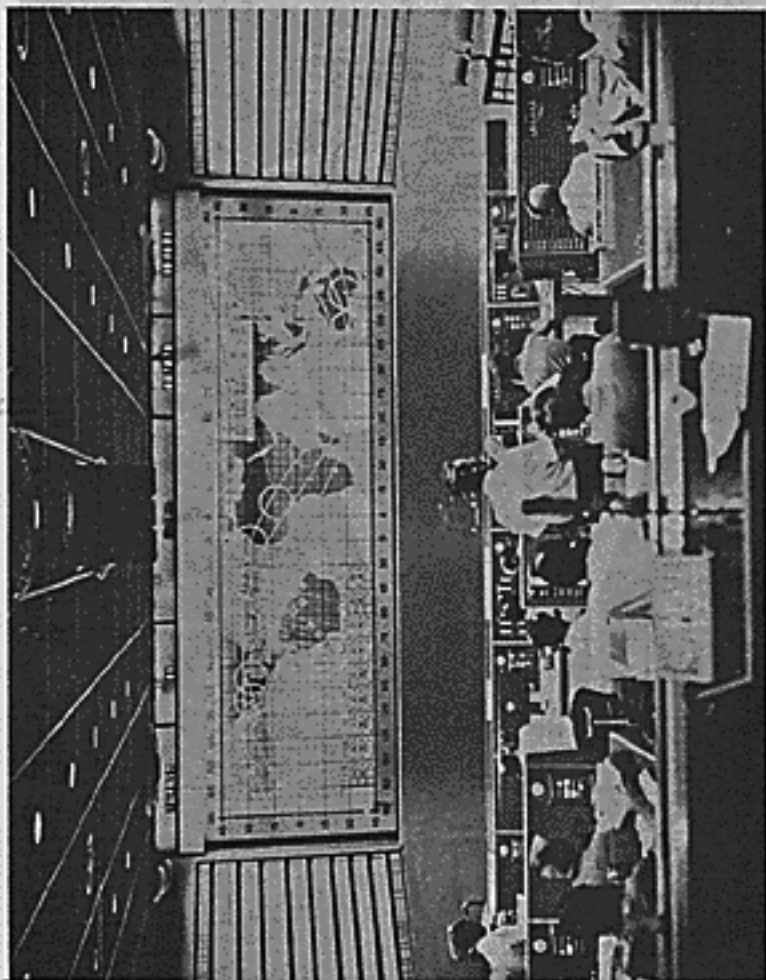




Three View of the Atlas Series B Missile

Commander Shepard's Mercury capsule Freedom 7 (Note straps holding retrorocket package).

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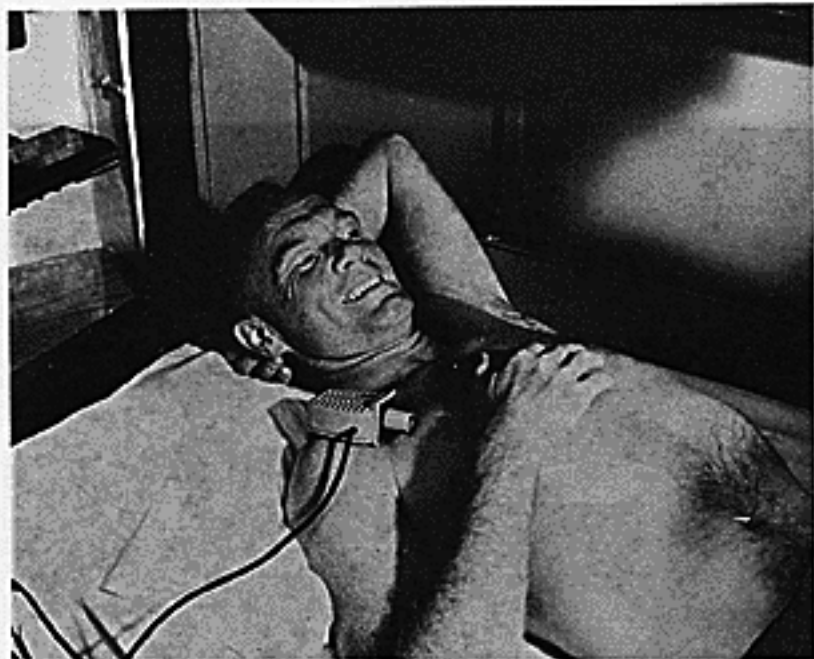


Project Mercury control center, Cape Canaveral, Fla.



Astronaut John H. Glenn, Jr.'s, spacecraft Friendship 7 being brought along side recovery ship U.S.S. Noa after world orbital flight.

The 13 Mercury ground stations around the world
World map showing the three earth orbits of the Mercury-Alias B research plane



Astronaut John H. Glenn, Jr., relaxes aboard U.S.S. *Randolph* immediately after world orbital flight.



PROJECT MERCURY GROUND STATIONS

- | | | |
|-----------------------|------------------------|--------------------------------|
| 1. CAPE CANAVERAL | 2. ZANZIBAR | 13. POINT ARGUELLE, CALIFORNIA |
| 3. GRAND BANKS ISLAND | 4. INDIAN OCEAN SHIP | 14. COCHIN, INDIA |
| 5. BERNABA | 6. HUEHUA, AUSTRALIA | 15. WHITE SANDS, NEW MEXICO |
| 7. MID-ATLANTIC SHIP | 8. YONIBERA, AUSTRALIA | 16. CORPUS CHRISTI, TEXAS |
| 9. CANARY ISLANDS | 10. CANTON ISLAND | 17. ELLEN, FLORIDA |
| 11. KAMP, NIGERIA | 12. CAVAL, HAWAII | 18. GRAND PIRE |

World map showing the three earth orbits of the Mercury-Atlas 5 launch, plus the 18 Mercury ground stations around the world.

APPENDIX C

CHRONOLOGY OF COLONEL GLENN'S DAY, FEBRUARY 20, 1962

- 2:20 a.m.—Colonel Glenn, who had gone to bed at 7 p.m., is awakened. Overhead the skies are cloudy. He shaves and showers.
- 2:45 a.m.—In white terrycloth bathrobe, he breakfasts on orange juice, scrambled eggs, filet of beef, toast with jelly, and postum.
- 3 a.m.—Physical exam starts.
- 4:30 a.m.—Starts wiggling into his tight-fitting space suit.
- 4:30 a.m.—T minus 120 minutes and holding. Overhead, a few stars show through breaks in the clouds.
- 4:45 a.m.—The stars have disappeared. Once again the launching is turning into a race with the seemingly unpredictable movement of the clouds.
- 5:01 a.m.—Glenn strides briskly out of Hangar S to the transfer van. In his left hand he carries a portable air conditioner. With his right he waves to the crowd outside the hangar.
- 5:18 a.m.—Van arrives at the launch pad, backs into place.
- 5:30 a.m.—T minus 120 and holding. The hold is extended another thirty minutes. Glenn waits in the van, waiting for a break in the clouds.
- 6 a.m.—The hold has been extended fifteen minutes. Glenn leaves van, smiling through his space visor. He shakes the hand of a ground crewman, and steps into the elevator that takes him to the "eleventh deck" or the top of the 109D Atlas missile.
- 6:03 a.m.—Feet first, he slowly eases his way into the capsule. (See p. 39.)
- 6:20 a.m.—The eastern skies begin to lighten, but overhead the clouds are still a forbidding black. A cool northern wind rustles across the cape.
- 6:25 a.m.—The countdown is resumed at T minus 120 minutes.
- 6:53 a.m.—The loudspeaker discloses there was trouble in the respiration measuring device in the space suit, but it has been fixed.
- 6:59 a.m.—The hatch goes on the capsule. Colonel Glenn is alone in his Friendship 7 capsule.
- 7:10 a.m.—T minus 75 and counting. The sun breaks out from behind the clouds.
- 7:20 a.m.—Broken bolt encountered in the hatch. The hatch will have to be removed and reinstalled. The skies are still gray.
- 7:25 a.m.—A hold is ordered at T minus 60 to replace the bolt and let the skies clear. Wind from west becomes brisk at ground level.
- 7:48 a.m.—Large patches of blue sky appearing.
- 7:52 a.m.—Broken bolt has been removed and hatch has been replaced.
- 8:05 a.m.—The countdown is resumed at T minus 60.
- 8:20 a.m.—A hold is ordered at T minus 45 minutes while ten gallons of fuel is added. The red gantry tower starts rolling back.
- 8:35 a.m.—The count is resumed at T minus 35 minutes.

8:40 a.m.—The liquid oxygen starts fuming out of the rocket. This is the crucial last phase of the countdown. Orange-jacketed Marines start climbing into their rescue helicopters at the Forward Medical Area.

8:55 a.m.—T minus 25 and counting. All systems appear "Go." The weather in the launch area and down range appears favorable.

8:58 a.m.—T minus 22 and holding.

9:11 a.m.—Mercury control announces that trouble has been found in a valve in the liquid oxygen equipment on the ground. Ten to fifteen minutes is required to fix the valve.

9:23 a.m.—Count is resumed T minus 22. The Marines prepare to take off in their helicopters.

9:25 a.m.—Countdown is at T minus 20 and counting.

9:35 a.m.—T minus 10 minutes and counting. Glenn and control center report all systems "Go."

9:40 a.m.—An electric power failure in a computer in Bermuda. Hold ordered at T minus 6:30. Estimate is that five minutes be required to fix the computer.

9:42 a.m.—Countdown resumed.

9:47 a.m.—Launch. The exhaust flame is blinding. The rocket gives off a staccato machinegun-like roar. It is going. (See p. 40).

9:47 a.m.—Mercury Control reports the rocket and capsule are going nicely.

9:48 a.m.—Colonel Glenn is weightless, reports the view is tremendous, a beautiful sight.

9:59 a.m.—Orbit confirmed.

10:09 a.m.—Tracking station in Kano, Nigeria, makes radio contact.

10:28 a.m.—Colonel Glenn high over the Indian Ocean, makes radio contact with Indian Ocean tracking ship. Colonel Glenn is reported doing fine.

10:40 a.m.—Colonel Glenn reports to tracking station at Muchea, Australia, that he is doing real well up there. Reports seeing the lights of Perth, Australia. "Thank them for turning them on," he says.

11:09 a.m.—Tracking station in Guaymas, Mexico, picks up Glenn.

11:21 a.m.—Completing first orbit, he talks to Mercury Control Center at Cape Canaveral. He reports seeing thousands of luminous particles near the capsule in the sunrise over the Pacific. Reports some minor difficulties in attitude control system and shifts to manual control. Says manual control is proving "smooth and easy."

11:37 a.m.—Colonel Glenn reports to Canary Island station that his status is excellent. On orders from the ground, he takes a deep breath.

11:42 a.m.—Colonel Glenn makes contact with station in Kano, Nigeria.

11:51 a.m.—Tracking station in Zanzibar acquires contact.

AFTERNOON

12:01 p.m.—Makes second contact with Indian Ocean tracking ship. Colonel Glenn's condition remains good.

12:10 p.m.—Talks with astronaut Cooper again at the station in Muchea, Australia.

12:16 p.m.—Contact with Woomera, Australia, station. Astronaut reports some difficulty maintaining attitude with the manual control system. Otherwise, everything "normal."

12:31 p.m.—Station at Canton Island reports contact.

12:39 p.m.—Capsule picked up by tracking station in Hawaii. Station reports Colonel Glenn's condition is good. He sends word he is ready to go for another orbit.

12:43 p.m.—Mercury Control Center announces it is continuing to analyze the attitude control difficulties to decide whether to terminate the flight with two orbits or go for planned three orbits.

12:45 p.m.—Flight director reaches preliminary conclusion that Colonel Glenn can go for another orbit.

12:46 p.m.—Station at Point Arguello, Calif., makes contact. Colonel Glenn talks with fellow astronaut, Walter M. Schirra, about attitude control problem.

12:50 p.m.—Mercury Control Center announces a decision to go for three orbits. Stations at Point Arguello and Corpus Christi, Texas, make contact.

12:56 p.m.—Cape Canaveral makes contact. Astronaut Alan B. Shepard greets Glenn: "Good afternoon, VII." Colonel Glenn reports he can see from the Florida east coast way back to the Mississippi Delta.

12:58 p.m.—Colonel Glenn, starting on third orbit, is picked up by Bermuda station.

1:12 p.m.—Atlantic tracking ship near African coast makes contact. Ahead is longest period, about twenty minutes, of no radio contact with earth.

1:34 p.m.—Indian Ocean ship picks up signals from Friendship 7.

1:43 p.m.—Colonel Glenn establishes voice contact with Muehea Station. Tells Astronaut Cooper to send following message to Marine Corps Commandant: "Have 4 hours' required flight time. Request flight chit be prepared for me."

1:51 p.m.—Flight station in Woomera acquires contact.

2:03 p.m.—Canton tracking station acquires contact.

2:12 p.m.—Station in Hawaii in contact. Colonel Glenn begins checking his retrofire sequence in preparation for his return to earth.

2:18 p.m.—Station at Point Arguello, Calif., picks up the capsule at moment of return.

2:20 p.m.—Retro firing sequence begun. Three retro-rockets fire. "It felt like it was going to send me clear back to Hawaii," Colonel Glenn reports. Spacecraft, however, continues onward, somewhat slower, and begins arching down to a landing in the Atlantic.

2:26 p.m.—Corpus Christi station makes contact.

2:28 p.m.—Cape Canaveral picks up the capsule. Colonel Glenn is now reentering the atmosphere. His speed is dropping sharply and the G forces are building up, so he will feel seven times his normal weight.

2:32 p.m.—Radio contact momentarily lost as heat of reentry builds up an ionized layer of atoms around the capsule.

2:34 p.m.—Radio beacon signal received by station at Grand Bahamas. Predictions are that capsule will land within a mile of destroyer.

2:35 p.m.—Voice communication reestablished. "Boy that was a real fireball."

2:37 p.m.—Drogue parachute deployed at 21,000 feet to steady the capsule.

2:38 p.m.—Main parachute deployed. "He is obviously an elated pilot," reports Mercury control center. Colonel Glenn seems to have returned safely from space. Destroyer Noa has capsule in sight.

2:39 p.m.—Colonel Glenn reports landing bag deployed at base of capsule.

2:42 p.m.—Colonel Glenn estimates he will land in one minute.

2:43 p.m.—Noa reports capsule has landed.

2:46 p.m.—Message from Noa: "Roger, seven, understand your condition is excellent."

2:51 p.m.—Noa closing on area of spacecraft. "We expect to pick you up shortly."

3:05 p.m.—Noa reports it picked up spacecraft at 3:01. Quotes Colonel Glenn as saying, "My condition is excellent."

3:12 p.m.—Colonel Glenn tells Noa crew he will assist in removing small pressure bulkhead, so he can crawl up through neck of capsule.

3:21 p.m.—Difficulty encountered in removing part of capsule top. Crew going to assist Colonel Glenn through latch.

3:24 p.m.—Mercury Control reports Colonel Glenn has left the spacecraft. "He is a hale and hearty astronaut after his history-making flight."

3:30 p.m.—Voice communication reestablished. "Boy that was a real thrill."

3:35 p.m.—Voice communication reestablished. "Boy that was a real thrill."

3:40 p.m.—Voice communication reestablished. "Boy that was a real thrill."

3:45 p.m.—Voice communication reestablished. "Boy that was a real thrill."

3:50 p.m.—Voice communication reestablished. "Boy that was a real thrill."

3:55 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:00 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:05 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:10 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:15 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:20 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:25 p.m.—Voice communication reestablished. "Boy that was a real thrill."

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4:35 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:40 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:45 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:50 p.m.—Voice communication reestablished. "Boy that was a real thrill."

4:55 p.m.—Voice communication reestablished. "Boy that was a real thrill."

5:00 p.m.—Voice communication reestablished. "Boy that was a real thrill."

area of maximum dynamic pressure. Pilot John Glenn is reporting some difficulty in the ground support equipment valve in the liquid loading system, T minus 22 minutes and holding.

0010—T minus 22 minutes and holding. We have encountered difficulty with the liquid oxygen loading valve out in the launch pad area. We are at T minus 22 and holding, and we estimate at this time an additional hold. This is Mercury Control.

0925—The MA-6 launch countdown has just resumed. We are at T minus 22 minutes and counting. The MA-6 launch countdown is proceeding; we are at T minus 22 minutes and counting.

0927—This is Mercury Control. The MA-6 countdown is at T minus 20 and counting. The countdown is at T minus 20 minutes and counting.

0930—This is Mercury Control. The MA-6 countdown is at T minus 15 minutes and counting.

This is Mercury Control. The MA-6 countdown is at T minus 10 minutes and counting. Mercury Astronaut John Glenn is reporting all the systems in the spacecraft are "Go"; our status report in the control center indicates all systems are "Go."

The MA-6 countdown is at T minus 9 minutes and 45 seconds and counting.

0940—This is Mercury Control. The MA-6 countdown is at T minus 6 minutes and counting.

0940—This is Mercury Control. We are at T minus 6 minutes and 30 seconds. We have encountered an electrical power failure in connection with our computers in Bermuda. The power has been restored, and we estimate that it will take us about 5 minutes to get the computer back in condition to support the mission.

0942—This is Mercury Control. We are at T minus 6 minutes and 30 seconds and counting; this is Mercury Control.

0943—This is Mercury Control. The MA-6 countdown is at T minus 5 minutes and counting.

This is Mercury Control; the MA-6 countdown is at T minutes and 30 seconds and counting.

This is Mercury Control, T minus 1 minute and counting. All systems are reported in a "Go" position. John Glenn is ready. This is Mercury Control, T minus 30 and counting. The Mercury space capsule umbilical is out. We are at T minus 19 seconds. T minus 10 seconds, 8, 7, 6, 5, 4, 3, 2, 1, 0, ignition, lift-off. The MA-6 vehicle has lifted off; projectile looks good. The MA-6 is off the launch pad at 47 minutes after the hour; it is climbing nicely; all systems are reported "Go."

The MA-6 vehicle is climbing freely. The trajectory is going OK; the MA-6 vehicle is still climbing nicely. It has passed through the

APPENDIX D

PUBLIC ADDRESS ANNOUNCEMENTS BY COL. JOHN POWERS BEGINNING AT T MINUS 22 MINUTES DESCRIBING MA-6 LAUNCH

0900—T minus 22 minutes and holding. We have encountered some difficulty in the ground support equipment valve in the liquid loading system, T minus 22 minutes and holding.

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The MA-6 countdown is at T minus 9 minutes and 45 seconds and counting.

0940—This is Mercury Control. The MA-6 countdown is at T minus 6 minutes and counting.

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This is Mercury Control, T minus 1 minute and counting. All systems are reported in a "Go" position. John Glenn is ready. This is Mercury Control, T minus 30 and counting. The Mercury space capsule umbilical is out. We are at T minus 19 seconds. T minus 10 seconds, 8, 7, 6, 5, 4, 3, 2, 1, 0, ignition, lift-off. The MA-6 vehicle has lifted off; projectile looks good. The MA-6 is off the launch pad at 47 minutes after the hour; it is climbing nicely; all systems are reported "Go."

The MA-6 vehicle is climbing freely. The trajectory is going OK; the MA-6 vehicle is still climbing nicely. It has passed through the

area of maximum dynamic pressures. Pilot John Glenn is reporting all systems "Go." He is giving routine reports reading off his instruments. John Glenn reports the flight very smooth now. The MA-6 launch vehicle is proceeding on its preplanned trajectory. John Glenn reporting his cabin pressure is now holding at 6.1 pounds per square inch. The MA-6 vehicle is still climbing on its trajectory. ***

Booster engine cutoff has been confirmed by the pilot. Telemetry indications in the Mercury Control Center confirm booster engine staging; the pilot has confirmed booster engine staging.

The pilot reports that the escape tower has separated. All telemetry in the Mercury Control Center confirms that the tower has separated.

The MA-6 vehicle is now climbing on its trajectory, 2 minutes and 5 seconds of flight time. It is on its preplanned trajectory, the pilot reports that the G forces are building up once again, *** acceleration of the sustainer engine. Bermuda reports that it has acquired telemetry signals from the spacecraft.

John Glenn reports everything looks good. The MA-6 vehicle is climbing nicely on its trajectory. John Glenn reports his fuel system as planned, his oxygen system is all OK, he reports his electrical power all OK. Our Bermuda station reports it has a track on the MA-6 vehicle. Glenn's cabin pressure now holding at 5.8 pounds per square inch. Glenn reports all systems are "Go." The MA-6 vehicle is approaching its sustainer engine cutoff point. Glenn reports all systems in the spacecraft are "Go." The *** trajectory still looks good.

From the Mercury spacecraft the sustainer has cut off as planned. John Glenn reports zero G and "I feel fine." He says the view is tremendous. Glenn reports he could see the booster turn around behind him. He advised that the sight of the booster behind him was a beautiful sight to see.

John Glenn reports he can see a very large cloud pattern back toward Cape Canaveral, and says it is a beautiful sight. Astronaut John Glenn now reports his spacecraft has turned around, the blunt heat shield is facing the direction of flight and is tilted up about 34° above horizontal. This is the desired preplanned orbital attitude.

All indications here are that we will be able to confirm orbit within a matter of a couple of minutes.

We would like to confirm the lift-off time as 9:47 a.m. e.s.t., at Cape Canaveral. The Friendship 7 spacecraft with Pilot John Glenn is now in contact with Bermuda. This is Mercury Control.

I have the figures on the cutoff conditions; that is, the engine cutoff conditions from the MA-6 vehicle in the orbital velocity and insertion details. ATLAS 109-D carrying the Friendship 7 spacecraft cut its final engine off approximately 503 miles east of Cape Canaveral at an altitude of approximately 100 miles. Its velocity at that time was approximately 17,500 miles. That means that the orbit of the Friendship 7 spacecraft will vary from a low altitude of about 100 miles to a peak altitude of about 160 miles. We estimate at this time that the period of the orbit will be approximately 89 minutes. All of these numbers will undoubtedly be clarified somewhat as we get more data on the orbit.

Under current conditions John Glenn and the Friendship 7 spacecraft is traveling at a velocity of 17,545 miles an hour and is in orbit

ranging from 100 miles at the perigee or low point to an altitude of 160 miles at its apogee or high point. At this time we have the tape recording of John Glenn's voice as he lifted off from Cape Canaveral and through the first 6 or 7 minutes of his flight. This is Mercury Control standing by while you hear these tapes.

5-4-3-2-1-0. Lift-off. The clock is operating. We are underway. Roger, read you loud and clear. Roger.

We are programming * * * OK.

It is a little bumpy along about here. Roger.

Stand by for 20 seconds. Roger.

3-2-. Launch. Roger.

Backup clock is started.

102, 101. Oxygen 78, 100. Amps 27. Roger.

Flight path is good. 6 0. Roger.

Checks OK. Minus 7 0. On your mark * * * coming up here now. Roger. Reading you clear, John. Coming into high gear a little bit. A little contrail went by the window, or something. Roger.

102 101. Oxygen 78 101. Amp 2 4 still OK. We are * * * out some now, getting out of the vibration area. Roger * * *. Flight path is very good. Pitch 4 3. Coming out real fine. Flight very smooth now. Roger. Flight path is good.

Cabin pressure is holding at 6 1 OK. Roger. Cabin pressure holding at 6 1. Roger.

Have had some oscillations but they seem to be damped. The clock 2 minutes, and fuel is 102. 101 oxygen 78, 102. G's are building to 6.

Roger, reading you loud and clear. Flight path looks good. Pitch 25. Standby for station.

BECO BECO [booster engine cutoff]. I see the tower go. I saw the smoke go by the window.

Roger. We confirm staging on PM. Roger.

Still have about one and a half G's. Roger. Over. * * * the tower went right then. I have the tower in sight way out.

Roger. We confirm on PM. * * * tower is green.

One and a half G's. Roger; loud and clear; flight path looks good.

Retro jettison. Emergency retro jettison slips off * * *.

Flight path looks good. Steering is good. Roger. Understand everything looks good.

G's starting to build again a little bit. Roger.

Roger, Bermuda. Standby. This is Friendship 7. Fuel 103 101.

Oxygen 78, 100. All voltages above 2.5 amps 2.6. Roger. Reading you loud and clear. Flight path looks good. Pitch minus 3. Roger.

Check that minus 7 on your minus 3. Roger. 7.

Fuel 13 101. Oxygen 78, 100. Amps 2.5. Cabin pressure holding at 5.8. Roger. Reading you loud and clear. Cape is "Go." We are standing by for you.

Roger. Cape is "Go" and I am "Go." I am in good shape. Roger.

All systems "Go." Oxygen 78, 100; cabin pressure holding steady at 5.8 amps is 2.6. All systems are "Go." Roger. 20 seconds. * * *

Flight path looks very good. Ten seconds. Flight path still looks good. Roger.

SECO [Sustainer engine cut off] * * * grade fired ok. Roger.

Stand by.

Roger. Zero G and I feel fine. Capsule is turning around. Oh, that view is tremendous. Roger. Turnaround has started. Capsule turning around and I can see the booster doing turnarounds just a couple of hundred yards behind. It looks beautiful.

Roger. 7. You have a "Go" of at least seven orbits. Roger. Understand "Go" for at least seven orbits.

Friendship 7. Can see clear back a big cloud pattern away back across toward the cape. Beautiful sight.

Roger. Still read you loud and clear. Next transmission Mercury Control: While you were listening to the tape of John Glenn's communications with the CapCom, Alan Shepard here in the control center, the Friendship 7 spacecraft has now passed over the Canaries and is about to establish contact with our tracking station at Kano, in Africa. As it passed in the vicinity of the Canaries, John Glenn reported, "I am very comfortable. All systems are OK."

He reported that the horizon was a brilliant blue and that he had the Canaries in sight out through his window. He also said he had a beautiful view of the African coast and that part of the Canaries were obscured by clouds.

The flight appears at this time to be proceeding as planned. Friendship 7 is in orbit passing in the vicinity of Kano, Africa, at this time. This is Mercury Control.

Mercury Control: The Friendship 7 spacecraft is in orbit with John Glenn at the controls. Contact was made with our tracking station in Kano at 9 minutes after 10, e.s.t. At the time of engine cutoff the ATLAS launch vehicle was approximately 503 statute miles away from its launch pad at Cape Canaveral. It was at an altitude of 100 miles. It was traveling at a speed of 17,530 miles. Further orbital details are the perigee, or low point, about 100 miles. The apogee, or high point, about 160 miles. Speed of the Friendship 7 spacecraft is now 17,545 miles per hour. All information we have as of this time indicates the mission is proceeding as planned. This is Mercury Control.

Friendship 7. Frequency is on automatic. pressure regulator is still in the position. Launch control is off. panel positions are normally. Are you receiving? Over.

Roger. Understand we have telemetry solid. Roger. You have telemetry solid.

Friendship 7. Fuel flow is 90, 98. I understand automatic is 90, 98. affirmative. roll of 2° right. 3.3°. The rates are all indicating zero. I am on ASCS at the present time. The clock is still set for time period for retrograde time of Z-4 plus 3 2, I have a retrograde time OK from Bermuda. Cabin pressure holding steady at 5.7. Cabin air 90. Relative humidity 30; coolant quantity 68. Environment is 65. Cabin pressure is indicated at 5.8. Suit environment is 65. Suit pressure is indicating 5.8. temperature is 60 on the suit. I am very comfortable; however, I don't just yet.

Mercury Control Center: The remotely relayed broadcast of John Glenn's voice was received by the Canaries in Bermuda and then transmitted back to the Mercury Control Center. This tape will be played over the public address system following this announcement.

At this time the Mercury spacecraft is in contact with our tracking station at Zanzibar. Contact was made at after the hour, e.s.t.

Friendship 7: * * * telemetry, all frequencies are on automatic. The pressure regulator is still in the IN position. Launch control is OFF * * * panel positions are normal * * * is off. Are you receiving? Over.

Understand. We have telemetry solid.

Roger. you have telemetry solid.

Fuel flow is 90, 98, repeat 90, 98.

Friendship 7: I understand automatic * * * is 90, 98.

Friendship 7: Roger, affirmative. Roll zero, yaw 3° right. Pitch 33°. The rates are all indicating zero. I am on ASCS at the present time. The clock is still set for time period for retrograde time of 0430, plus 28. I have a retrograde time OK from Bermuda.

Cabin pressure holding steady at 5.7. Cabin air 90. Relative humidity 30; cooling quality 68. Suit environment is 65. Cabin * * * indicating 5.8. Suit temperature 60 on the suit. I am very comfortable; however, I don't want to * * * down just yet. Primary oxygen is 78, secondary 102 * * * is 34. No. 1 is 25. 25. Standby 1 is 2.6. Standby 2 is 25. Isolated 29. Back on main. Ammeters indicating 2.3. ASGS is 112 * * * 112. Over.

I understand. I understand your retro sequence time is 043228. Over. Friendship 7. That is affirmative. That is what is set in the clock. The horizon is a brilliant blue. There I have the mainland in sight at present time coming up on the scope and have the Canaries in sight through the window and picked them up on the scope just before I saw them out the window. Over.

Roger.

All indications from the tracking network now are that John Glenn and his Friendship 7 spacecraft have passed out into the Indian Ocean. He is now flying over the Indian Ocean approaching our Indian Ocean ship. A report from our Kano Station indicates the astronaut's status is "Go." He sounds like he is in excellent voice, his heart action is excellent, and we have an indication he did his first eating as he passed over Kano. He has performed a yaw maneuver, and has exercised the manual control systems. As of this time the Friendship 7 flight, the spacecraft is approaching the Indian Ocean ship, all systems indicate "Go" at this time. This is Mercury Control.

The next voice tape will probably be after the spacecraft passes over Muchea.

This is Mercury Control. The Friendship 7 spacecraft with Astronaut John Glenn at the controls is flying high over the Indian Ocean at this time. He made initial contact with the Indian Ocean ship at 28 minutes after the hour, 10:28 a.m. e.s.t. All the information here at this time indicates the flight is proceeding normally; all of our contacts with the pilot indicate that he is feeling fine; our flight surgeon here in the control center, looking at data fed him from the control network, indicates the pilot is in a completely normal situation and proceeding in an excellent condition. This is Mercury Control with the Friendship 7 over the Indian Ocean ship at this time.

This is Mercury Control. Our tracking station located at Muchea, Australia, reported contact with Friendship 7 spacecraft at 40 after the hour; that is 10:40 a.m., e.s.t. Astronaut John Glenn is now in voice contact with Astronaut Gordon Cooper who is the communicator at Muchea. In the conversation John has indicated "I am doing very well up here, all systems are 'Go.' I am having no problems at

all." He described his sight; he talked about cloud cover after he passed over the coast of Africa and the Indian Ocean. He reported a high glare on the night side of the world. The voice communications have reported at this time. They will be broadcast shortly after the pass-on around Muchea, Australia. This is Mercury Control.

John Glenn in the Friendship 7 spacecraft is carrying on a conversation with Astronaut Gordon Cooper at Muchea, Australia, as he passes over the Australian Continent. It is reported that he has observed very bright light and from his discussion with Gordon Cooper assumes that he is observing the city of Perth, Australia. In a message to Gordon Cooper, he says, "Thank everybody for turning them on." Meaning, of course, the lights. Our tracking station at Woomera, Australia, reports contact with the spacecraft at 43 minutes after the hour, 10:43 a.m., e.s.t. This is Mercury Control.

The Friendship 7 spacecraft with Astronaut John Glenn at the control has now passed east of the Australian Continent. As he passed over Australia he advised that he could not see the city of Woomera because he had a lot of clouds over the Australian Continent. The Woomera tracking station has reported all data received during the past gives every indication that John Glenn is completely normal—that includes his electrocardiogram, his respiration rate, and his blood pressure. Dr. Bill Douglas, the astronaut's flight surgeon, has just advised me that Astronaut John Glenn has two tubes of specially equipped food aboard his spacecraft, one containing fruit and one containing meat. He also has malted milk tablets aboard. The Friendship 7 spacecraft is now coming up in the Pacific Ocean flying toward Hawaii. This is Mercury Control.

We have the tape recording of the remotely relayed voice contact between Astronaut John Glenn and Astronaut Gordon Cooper as the Friendship 7 spacecraft passed over Australia. We are prepared to play this tape for you at this time. Stand by for the tape recording of Astronaut John Glenn's conversation with Cooper. This is Mercury Control.

Hello, Coop, this is Friendship 7 reading you loud and clear.

Roger, Friendship 7, this is Coop. Over.

Roger.

How are you doing, Colonel?

We are doing real fine up here, everything is going real well. Over.

Very good, John, you sound good.

Roger. Control fuel is 90,100; oxygen is 75,100; amps are 2.2. All systems are still "Go"; having no problems at all. Control system operating fine. Over.

Roger. Do you have any landmark observations?

Roger. I was just making some for the recorder, and the only unusual thing I have noticed was the rather high, what appeared to be a haze layer up some 7° or 8° about the horizon on the night side, the stars I can see through it as they go down toward the real horizon, but it is a very visible single band, or layer or * * * above the normal horizon. Over.

Roger. Very interesting.

Friendship 7: I had a lot of cloud cover coming off of Africa. It has thinned out considerably now and although I can't definitely

see * * * there is a lot of moonlight here that reflects off of what clouds there are. Over.

Roger. * * * an excellent * * * John.

Your yaw and check on ATS is good. The yaw on fly-by-wire is excellent. Over.

Roger. We had better check the * * *. Over.

Roger. Go ahead.

Shortly you may observe some lights down there. Do you want to take a check on that, to your right. Over.

Friendship 7: Roger. I am all set to see if I can't get them in sight.

You did have your visor closed?

I did have it opened for a little while. It is closed now. Cabin pressure is holding in good shape. Over.

Roger. * * * count is off. Over.

Roger.

Friendship 7: I feel fine. Over.

Good show.

Relay inverter is 180°. It looks like it has done pretty well.

Roger. It looks like it is holding out fine.

Friendship 7: That was sure a short day. That was about the shortest day I have ever run into.

Time passes rapidly, eh?

Yes, sir.

OK. Do you have any landmark observations to make? Over.

This is Friendship 7. I have a * * * picking up some of these star patterns better than I was just off Africa.

Have you sighted Orion yet? Over.

Friendship 7: Am negative. Do not have Orion in sight yet.

Roger. Within a few seconds you should have Orion and Cor—* * * and Sirius probably in sight; very shortly thereafter Orion will be off to your right. Over.

Roger.

Do you have time to send us a blood pressure reading? Over.

Roger. Stand by.

Standing by for blood pressure whenever you—

Roger. I am already sending it to be picked up. Over.

Roger. You are in good shape.

Roger. I do have a light * * * on the ground. Over.

Roger. Just off to your right, there?

Friendship 7: Just to my right I can see a big pattern of light. Apparently right on the coast. I can see * * * and a very bright light just to the south of it.

Roger. That is Perth and Rockingham you see there.

Roger. The lights show very well. * * *

Roger. Sure will, John.

Friendship 7: On down to the south and inland I can see lights. There are two, actually four, patterns in that area. Also coming into sight in the window now another one, almost down under me. The lights are very clear from up here.

Roger, John; good.

Friendship 7, we have your blood pressure read, blood 26 over.

* * *. Let's have the results of your physiological tests. Over.

The Friendship 7 spacecraft made contact with our ground station at 37 minutes after the hour, that is 11:37 a.m.

This is Friendship 7. I have had no ill effects at all yet from any . . . is still excellent . . . No nausea or discomforts whatsoever. Over.

(Balance of tape not clear enough to transcribe.)

We intend to make available to you an unofficial transcript of the conversation between the Cap Con and the Friendship 7 pilot. Please understand at the present time this is taken by very fine stenotypists; however, they are not experts on the technical angles of this particular mission. We will make it available to you on these grounds, with the promise that an official transcript of the conversations between Cap Con and Friendship 7 will be made available later when we have time for listening and clarification of numbers and so forth. This is strictly for your guidance. This is unofficial at this time. It is being made available, however.

There is also a question by several people about the reference to seven orbits. What this concerns, naturally, is that at insertion the spacecraft was capable of making seven orbits. We have no plan for seven orbits, of course, as we told you earlier.

The tracking station located at Guaymas, Mexico, reported initial telemetry contact with the Friendship 7 spacecraft at 09, that is 11:09 a.m. Voice contact has been established; however, we are not able to read it very clearly at this time. We do know that they are in voice contact, that is, John Glenn from the Friendship 7 spacecraft and our communicator at the Guaymas, Mexico, tracking station. As of this time all systems appear to be in a "Go" condition; our cabin temperature is a little bit higher than it was up to about 105° to 108°, but we do not feel that this is any particular concern at this time. This is Mercury Control with the Friendship 7 spacecraft approaching the west coast of Mexico.

Our initial contact with the Friendship 7 spacecraft here in the control center was established at 21 minutes after the hour; that is 11:21 a.m., a.m., e.s.t. We were able to hear the remote relay of a voice contact between John Glenn and our tracking station at Guaymas, Mexico. During that voice broadcast Glenn reported that he had observed some small particles near the capsule, moving at approximately the same speed as it came through the sunrise phenomenon. These particles caused him no difficulty, but he did observe them during the flight. They appeared to glow in the sunrise. As he passed across the southern part of the United States, Glenn reported some minor difficulty with his attitude control system. As of this time Glenn is manually flying his spacecraft on what we call fly-by-wire, a form of automatic pilot type device. He made contact with the Bermuda tracking station at 26 minutes after the hour; that is 11:26 a.m., e.s.t. He was continuing to maintain attitude control with the fly-by-wire system. He reported that it was very smooth and that he was not having any trouble controlling the spacecraft. As he passed across the east coast of the United States he reported he had a beautiful view of the coast. He, at that time, could not see the Cape, but expected to do so shortly. He has now passed east of Bermuda going down the second leg of the second orbit in the Friendship 7 spacecraft. This is Mercury Control Center.

Based on data recorded for the first orbit, we have a period of 88.29 minutes.

The Friendship 7 spacecraft made contact with our Canary Islands tracking station at 37 minutes after the hour; that is 11:37 a.m.,

e.s.t. At that time, John Glenn reported that his status was excellent. He was maintaining control of the spacecraft by using his manual fly-by-wire system. He was asked by the ground controller to take a deep breath so that he might get an indication of his respiration rate. His answer was "Roger; taking a deep breath." Apparently John was getting quite a bit of sunshine through his window. He reported that the sun was bright and he was feeling pretty warm as a result of the sun streaming through the window. As of this time the Friendship 7 spacecraft is passing over the western coast of Africa.

Aside from the problems that we are having with his attitude control system, and these apparently are not serious, because he is maintaining good control over the spacecraft, all systems appear to be operating properly.

The Friendship 7 spacecraft has made contact with the Kano tracking station at 72 minutes after the hour; that is 11:42 a.m., e.s.t. We now have the tape recordings made during the pass of the Friendship 7 spacecraft across the southern United States, in which Astronaut John Glenn had voice contact with Alan Shepard here in the control center. That tape is ready to play now. Stand by for the tape recording. This is Mercury Control. Out.

Friendship 7, this is Canaveral.

Friendship 7 to Canaveral. Read you loud and clear. Over.

Roger, Friendship 7, read you loud and clear, standby for * * *, please.

Roger.

Friendship 7, this is CapCom. Would you give us the difficulty you were having in the yaw? Over.

Roger. This is Friendship 7. I am going on fly-by-wire so I can control more accurately. It just started as I got to Guaymas, and it appears to drift off in yaw to the right at about 1° per second; it would go over to an attitude of about 20°, then hold, and then when it hits at about a 20° point it then goes into orientation mode and comes back to zero, and it was cycling back and forth in that mode. I am on fly-by-wire now; I am controlling manually. Over.

Roger. Understand. Do you have retrofire times for 2-B and 2-C?

This is Friendship 7. Negative.

OK. 2-B, 01 50 00, and 2-C, 02 05 59, over.

This is Friendship 7. Understand 1-B is 01 50 00, 2-C—that should have 2-B—is 01 50 00 and 2-C is 02 05 59; is that affirmed?

That is affirmative. Stand by, please.

This is Friendship 7. What appears to have happened is I believe I have 1-pound thrust in left yaw, so it drifts over out of limits and then hits it with the high thrust. Over.

Roger, Friendship 7, we concur here. Recommend you remain fly-by-wire.

Roger, am remaining fly-by-wire.

Roger, Friendship 7, we are having a little difficulty. Start off on your 30-minute report.

This is Friendship 7, controlling manually on fly-by-wire, having no trouble controlling, very smooth and easy; it controls very nicely. Fuses are still the same on the left panel.

Roger.

Fly-by-wire autogyro is normal. All T handles are in, retro delay is normal. I have a beautiful view out of the window of the coast at the present time; am just departing, can see away down across Florida; cannot quite see the Cape yet. Continuing this report there are no sequence panel lights showing, only abnormal position landing bag is off; the EPI is indicating OK, the control fuel is 80 auto, 100 manual. Retrograde time set in is 04 32 28. Over.

Roger, still reading you. Are we in communications yet? Over.

Roger. I will be out of communication fairly soon and thought if the other call was in would stop the check. Over.

Not as yet; we will get you next time.

Colonel Glenn (continuing report). Cabin pressure 55, and holding nicely. Cabin air is 95. Relative humidity 20, * * * 67, temperature is 67 on the suit. Oxygen is 70, 100; amps are 22. The only real unusual thing so far beside ASCS trouble were the little particles, luminous particles, around the capsule—just thousands of them right at sunrise over the Pacific. Over.

Roger. We have all of that. It looks like you are in good shape. Remain on fly-by-wire for the moment.

Roger. Friendship 7.

This is Mercury Control. We have been asked about the fly-by-wire. Essentially this is the system in which the pilot moves the control handle, this sets a signal to a type of black box system, which in turn operates the valve. This is different from the manual system in which the astronaut also controls the handle, but the connection with the valve is by mechanical linkage. In the fly-by-wire, the astronaut controls the handle electronically, the valve operates.

This is Mercury Control. The Friendship 7 is proceeding in its orbital flight around the earth. It is in its second orbit around the earth at this time. As of 51 minutes after the hour, that would be 11:51 a.m., e.s.t., our tracking station is Zanzibar reported a contact with the spacecraft. At 12:01 p.m., e.s.t., the Friendship 7 spacecraft made contact with the Indian Ocean ship. Astronaut John Glenn is still controlling the attitude of the Mercury spacecraft with the fly-by-wire manual control system. This is a system in the spacecraft in which movements of the control handle by the pilot send electrical impulses into the black box which in turn cause the valves at the perimeter of the spacecraft to open allowing the hydrogen peroxide to escape. These are ejects that effect the changes in the attitude of the spacecraft. This differs from his normal manual system in that the black box is spaced between the pilot and the valve. In the full manual system he has a mechanical linkage to these valves. Friendship 7 spacecraft is now over the Indian Ocean ship about in the center of the Indian Ocean. As a matter of interest, because of cloud cover and winds, the * * * experiment which was planned from the Indian Ocean ship has been canceled. Astronaut John Glenn's condition remains good; his attitude is good and he is working as a test pilot. This is Mercury Control.

We have the tapes of Friendship 7 passing over the Canary Islands and the African coast; the tapes are ready to be played. Stand by for the tape recording.

This is Friendship 7, my status is excellent. I have control of capsule on fly-by-wire at present time. Control fuel is 80, 100; oxygen is 60, 100; amps 22. Over.

Understand your auto fuel is 80, your * * * is 100. Oxygen 69, 100; amps 22. Over.

Roger. This is Friendship 7 * * * depressed.

That is good.

This Friendship 7. Have Cape Verde Islands in sight off my left. Over.

Roger. Understand. Friendship 7, your medical status is excellent.

Roger. Friendship 7, the sun is coming through the window and is very, very warm where it hits the suit. I get quite a bit of heat from it.

Roger. Understand.

Cape flight, this is Canary system.

Go ahead.

We just got a * * * from the capsule.

Understand.

Put you back on the air.

Roger. Understand.

This is Friendship 7. We will do the horizon check now.

Standing by.

This is Friendship 7, coming up through 14°.

I got your * * * degrees from the ground.

We are reading you at about 14.

This is Friendship 7. I have no problem at all controlling on the horizon.

I understand you have no problem at all controlling on the horizon?

That is affirmative.

(End of latest tape.)

This is Mercury Control. The Friendship 7 spacecraft made contact with our tracking station at Muchea, Australia, at 10 after the hour; that is 12:10 p.m., e.s.t.

Astronaut John Glenn is now in voice contact with Gordon Cooper at Muchea, Australia.

Sergeant * * * [recording not decipherable].

(This recording did not come through the speaker.)

Our tracking station on Canton Island reports contact with the Friendship 7 spacecraft at 12:31 p.m., e.s.t. And our station on Hawaii reports contact at 12:39 p.m., e.s.t. We are continuing to analyze the difficulties in the attitude control system. The fact that the pilot is aboard and has the ability to analyze his problem and take judgmental corrective action is a demonstration of the value of man in space flight.

We will continue to analyze the progress of the flight and make our decisions * * * to make sure that we fire the mission as best as possible.

We have now had a summary status report from our flight control center in Hawaii which reports the astronaut's status was good, the status of the systems on board the spacecraft were good, except for the difficulties of the attitude control system.

In a voice contact broadcast and relayed remotely to the control center, Astronaut John Glenn reported that he is "Go" for another orbit. Our analysis of the situation at this time is that we are in a "Go" condition; our flight director, Mr. Chris Kraft, has made a preliminary decision at this time that we are "Go" and will continue the mission.

This is Mercury Control with the Friendship 7 spacecraft approaching the west coast of the United States coming around the tail end of his second orbit around the earth.

The tracking station located at Arguello, Calif., made contact with the spacecraft at 12:46 p.m., e.s.t. Astronaut John Glenn is in voice contact with Astronaut Wally M. Schirra, the Cap Com at the Point Arguello Station.

... are being relayed to the Mercury Control Center on a remote control basis. These voices are coming in loud and clear and we have made the decision at this time to go for the third orbit. Astronaut John Glenn is working back and forth now with Wally Schirra and they are discussing the pros and cons of the various approaches they might take in handling this attitude control situation.

They are also giving John Glenn revised retrorocket firing times for the ... contingency landing areas that are available to us throughout the third orbit.

The Mercury spacecraft is now over the western coast of Mexico or southern California, flying at the beginning of its third orbit. Astronaut John Glenn sounds good. He sounds interested and eager to perform his mission.

This is Mercury Control. We now have a contact with our Guaymas, Mexico, station at 12:50 p.m., e.s.t., and with the Corpus Christi, tracking station at 12:52 p.m., e.s.t.

As Astronaut John Glenn passed across the southern portion of the United States and began winging his way away from the Punto Arguello Station, he and Astronaut Wally Schirra had a very interesting exchange. Schirra called him up and said, "John, the aeronauts are very happy with you up there."

Glenn replied by saying, "I feel real good, Wally. No problems at all."

Schirra responded by saying, "Good show. See you next time around."

The Friendship 7 spacecraft is now crossing the northern borders of Texas across the southern United States, and is now committed to its third orbit. This is Mercury Control.

The tracking and communications equipment here at Cape Canaveral made contact with the Friendship 7 spacecraft and Astronaut John Glenn at 12:56 p.m., e.s.t. Astronaut Alan Shepard, talking from here in the Mercury Control Center, carried on a conversation which began, "Good afternoon, Southern." And then they worked out retrorocket firing times, clock changes, and other procedural matters.

At 12:58 p.m., e.s.t., contact was made by the Bermuda station. Passing between Florida and Bermuda, John Glenn had a pretty good look at the State of Florida, and for that matter the whole southeastern United States.

John held the Cape in sight—"It looks real fine. I can see the whole State of Florida laid out like a map. I can still see clear back to the Mississippi Delta."

The Friendship 7 spacecraft is approximately over Bermuda ... at this time, traveling down its third orbit around the earth. Astronaut John Glenn still sounds good and is still working hard at his mission. This is Mercury Control.

We blew the hatch on the side after checking to see that the hatch was clear outside, and came on out through the side hatch. I was

These are tape recordings of the voice transmissions of Astronaut John Glenn and his exchanges with his fellow astronauts Wally Schirra at Ponto Arguello, Calif., and Alan Shepard at Cape Canaveral. These tapes are ready to go now. Stand by for the tape recordings:

This is Friendship 7. How do you read? Over.

* * * We read you loud and clear.

All systems are still "Go." I had some erratic ASCS operation and I caged and uncaged on the night side and it appears to be working very well now, although I was drifting again in roll a moment ago. It appears to have corrected itself in roll, however, without me caging again now.

Very good. [Tape not understandable at this point.]

If you could, would you give me your attitude and will check over * * *

Roger. I will come back into orbit attitude * * * at the present time.

We have TM solid at this time. It looks real good here.

Your roll is 5 left, yaw 3 right, pitch minus 3.2 right now.

Roger.

[Recording not clear.]

John we checked out on the button with your attitude of 2°.

Roger. I appear to have a drift in the scope.

Roger. Apparently it is more difficult to pick up drift than I thought it would be.

Your best bet is to look out the window and try and get something moving away from you out the window.

Roger. I got you there.

You understand that your capsule elapsed time is running about a second slow compared to EET?

No; I was not aware of that on the elapsed time.

Roger. This will affect your sequence times. I will give you * * * if you are ready to copy. [Tape not clear.]

Friendship 7, fuel 62 * * * oxygen is 62, 95; amps 23. Over.

Good afternoon, Seven. Radio loud and clear. * * * [Tape not clear.]

3 22 26.

Roger. 3 22 26. [Tape not clear.]

That is correct. At this time change your retro setting manually to 204 302 38. Over.

Roger. 04 plus 32 plus 38.

Roger. Retrograde fire is reset to 04 plus 32 plus 38. Over.

Roger, Seven. We recommend for the third orbit that you use the gyro as you desire, either * * * or free, so that in the event fire, to retrofire on the third orbit is that the scanners in ACSC do not program properly you may use the gyros in the * * * position for your attitude reference. Over.

Roger, Friendship 7. I have a pretty good lineup now on the gyros, I believe. The check that I made on the night side was OK but they drifted off again, apparently. Rather rapidly, in fact. I got another check on it and they seem to have corrected that pretty good now. I did not have to change them again. Over.

Roger. * * * The only problem is that you may not have enough light time prior to retrofire. So can I hear how the gyros worked and the free position, if you desire. Over.

Roger.

Also, Seven, we recommend that you allow the capsule to drift on manual control in order to conserve fuel. Over.

Friendship 7.

This is Cape. Stand by for * * *

Correct your * * * time to 03 22 22, for 3 Bravo.

Roger.

Now Seven, I am having trouble. The second should be 32.

Roger. 03 22 32.

Next transmission Bermuda.

Roger.

Our Atlantic tracking ship made contact with the Friendship 7 spacecraft at 1:12 p.m., e.s.t. Friendship 7 is now proceeding toward the continent of Africa, going around in its third orbit in this first manned orbital flight of Project Mercury. This is Mercury Control.

We have approximately 2 more minutes of voice tape, a recording of Astronaut John Glenn's voice in conversation with our Bermuda tracking station. Stand by for the broadcast of the tape.

Friendship 7. I have the Cape in sight. I can see the whole State of Florida just laid out like a map. Beautiful. I can still see clear back to the Mississippi Delta. Down in the area hotel * * * on the weather * * * and it looks very good down that way. It looks like we will have no problem on recovery.

So the Indian Ocean ship located in the center of the Indian Ocean has made contact with the Friendship 7 spacecraft, at 1:34 p.m., e.s.t. Information available here at the control center at this time indicates that the mission is proceeding satisfactorily and that John Glenn is in excellent condition. This is Mercury Control.

The Friendship 7 spacecraft made contact with our Mercury tracking station at Muchea, Australia, at 1:43 p.m., e.s.t. Astronaut John Glenn is now in voice contact with Astronaut Gordon Cooper at the tracking station. Just a couple of minutes ago, John called up Gordon Cooper and said, "Hey, Gordon, I want you to send a message for me. Send a message to the Commandant of the U.S. Marine Corps that reads: 'Have 4 hours required flight time. Request flight check be prepared for me. Signed, John Glenn, lieutenant colonel, U.S. Marine Corps.'"

At this time, John is in voice contact with the Muchea tracking station and Gordon Cooper discussing the technical systems on board the spacecraft.

John Glenn is feeling very well, doing very well on the mission. The spacecraft is proceeding down the third orbit and should be coming around across the Pacific within the next 15 or 20 minutes. This is Mercury Control Center.

The tracking station at Muchea, Australia, made contact with Friendship 7 at 1:43 p.m., e.s.t., and the station at Woomera, Australia, at 1:51 p.m., e.s.t. Flight Controller, Muchea, confirms the spacecraft in a "Go" condition as it passed over Muchea.

We have about 2½ minutes of tape recorded in both broadcasts from the astronaut, acquired from Australia. Stand by for the tapes.

* * * on the right side, everything is outboard, except for the warning light which is on inboard * * *

The only two * * * [tape not clear; run at too fast a rate].

Control settings on the water. [Tape not clear.]

Setting on the * * * is beyond the 1.7 mark which is the maximum setting.

Roger. I understand.

What is your opinion on the general problem, John?

I don't know. I want to start lining up just as carefully as I can here in a minute, to see whether the scanners will pick it up and correct it in so we have a retrofire; if not, I will align it myself. Over.

Roger. Do you have your 3 Dog Easy * * * times from the Indian Ocean ship?

Yes; I did. I got those OK.

I give you a recommend change of retrofire to 04 32 37.

(Tape not clear.)

Are you on manual proportional or fly-by-wire now?

(Tape not clear.)

The Mercury tracking station on Canton Island contacted the Friendship 7 spacecraft at 2:03 p.m., e.s.t. The tracking station on Hawaii contacted the Friendship 7 spacecraft at 2:10 p.m., e.s.t. As we proceeded around from Australia to Hawaii, we detected an indication of a problem with the heat shield * * * switch. A check was made over Hawaii which confirmed that the system was operating properly and that the signal apparently was erroneous. He is also concluding now his retrofiring checklist. This is a process by which we make sure that all his onboard equipment is secured; that he has checked out his attitude control system; that he is in good condition and preparing to fire the retrorockets to begin that long landing flight toward the Atlantic. This is Mercury Control.

Our California station has made contact with the Friendship 7 spacecraft at 2:18 p.m., e.s.t. At 2:20 p.m., e.s.t., the retrorocket sequence was initiated in the spacecraft. Retrofiring attitude was assumed and the three retrorockets have fired. This has been confirmed by the pilot and by our telemetries here in the Mercury Control Center.

John Glenn's comment was that it felt like it was going to send him clear back to Hawaii. The retrorockets have fired, the reentry process will be initiated shortly. This is Mercury Control.

The tracking station at Guaymas, Mexico, established contact with the Friendship 7 spacecraft at 2:23 p.m., e.s.t. We have confirmation of retrorocket firing; we have instructed Mr. John Glenn to retain his retrorocket packet at least until he gets over Texas. This is a precautionary measure to further check on the erroneous switch location information we had earlier. John feels that he held his attitude properly during the retrorocket firing process and says that he can see the coast of California. He is now reporting cloud cover down toward Mexico. The spacecraft is now arcing down on its landing trajectory toward the Atlantic. This is Mercury Control.

The Corpus Christi tracking station made contact with the Friendship 7 spacecraft at 2:26 p.m., e.s.t. We are in contact with Astronaut John Glenn. As a precautionary measure we have asked him to retain his retrorocket pack. We have just made initial contact with the Mercury spacecraft at Cape Canaveral, 2:28 p.m., e.s.t.

On the basis of his present flight plan we would estimate a landing at approximately 37 or 38 minutes after the hour. This is Mercury Control.

Friendship 7 spacecraft is approaching the coast of Florida at this time. During his reentry process. We have advised him that the weather in his landing area involves one-tenth cloud cover and 10

miles visibility. This should not present any hazard at all during the landing operation.

He is now maintaining control of his spacecraft using the fly-by-wire system as a back up. This is Mercury Control.

Mercury Control: We estimate that the Friendship 7 spacecraft is now encountering the atmosphere of the east coast of Florida. He is encountering the atmosphere. We estimate that an ionization layer involved in the reentry process is prohibiting us from having direct communication with him.

This is Mercury Control. The Mercury spacecraft is in its reentry process at this time. We have an indication that receiving equipment at Grand Bahama Island is receiving beacon transmissions from the spacecraft; we are not receiving any voice communication at this time. On the basis of his present flight trajectory we estimate that he will land within about a mile of a destroyer associated with the U.S.S. *Randolph* at the end of the third orbit. This is Mercury Control.

We are still not receiving any voice communication from the spacecraft; we are, however, receiving electronic transmissions from the spacecraft.

We have just reestablished voice communication with John Glenn; he is in the process of reentering the atmosphere; we expect the landing shortly. His landing is expected to be within about a mile from a destroyer associated with the U.S.S. *Randolph* in the recovery zone at the end of the third orbit. This is Mercury Control.

We have established good voice communications with Astronaut John Glenn. His comment just a second ago, "Boy, that was a real fireball." We anticipate the drogue parachute deployment in about a minute and a half. About 1½ minutes before drogue parachute deployment. John says he feels fine. This is Mercury Control.

Our voice communications with the Friendship 7 spacecraft are becoming somewhat sporadic at this point. Mercury Control is standing by.

This is Mercury Control. We have received a report from the pilot that the drogue parachute has been deployed.

This is Mercury Control. Astronaut John Glenn in the Friendship 7 has confirmed the deployment of his drogue stabilizing parachute. We have reasonably good voice communication with him now. He sounds good. He is working. This is Mercury Control.

This is Mercury Control. We have a very elated pilot at this time because he has just reported the deployment of that main landing parachute, that "beautiful," as he calls it, "63-foot ring" * * * parachute that will ease him down onto the surface of the ocean. He is obviously an elated pilot.

This is Mercury Control, we are listening in on a conversation between Astronaut John Glenn and one of the recovery force ships.

This is Mercury Control. The surface ship has reported that it found a radar chaff deployed out of the spacecraft at about 10,000 feet on its radar scopes. It was able to track; it has visible observation of the spacecraft coming down.

This is Mercury Control. We have a report from downrange that the destroyer, the U.S.S. *Nox* has the spacecraft in sight; the spacecraft is now descending in its parachute toward the surface of the ocean.

Astronaut John Glenn reports that all systems are still "Go"; he has deployed his landing bag and reports it green.

This is Mercury Control. The U.S.S. *Noa* going under the code name "Steel Head" estimates that it is 6 miles from the Friendship 7 spacecraft with the pilot John Glenn aboard. This is Mercury Control.

The spelling, the way we receive it, is N-O-A.

Astronaut John Glenn reports that he estimates 1 minute to landing on the surface of the ocean.

The U.S.S. *Noa* reports the spacecraft is on the water and is now attempting to make voice contact with the pilot. Landing time is estimated at 2:43 p.m., e.s.t.

This is Mercury Control. The U.S.S. *Noa* broadcasting from the recovery area has just broadcasted a message indicating "Roger. Friendship 7, understand your condition is excellent." We are not receiving direct voice broadcast from the spacecraft, but we are receiving the ship's transmission. This is Mercury Control.

Information from the U.S.S. *Noa* indicates that it is closing into the immediate vicinity of the spacecraft. We anticipate pickup shortly. This is Mercury Control.

The reports from the U.S.S. *Noa* indicate the Friendship 7 spacecraft was picked up clear of the water at 1 minute after 3, e.s.t. John Glenn reports "My condition is excellent." They are in the process now of opening up the spacecraft to remove John Glenn from the spacecraft. This is Mercury Control.

The spacecraft has been set on the deck of the U.S.S. *Noa*.

This is Mercury Control. We are still maintaining radio contact with the U.S.S. *Noa*; the spacecraft Friendship 7 is on the deck at 4 minutes after 3, e.s.t., this afternoon. Astronaut John reports "My condition is excellent." He is in continuous contact with the people on the ship. This is Mercury Control.

Friendship 7 is resting on the deck of the U.S.S. *Noa* in the South Atlantic. Arrangements are now being made to let the astronaut crawl out the upper neck of the spacecraft onto the deck of the destroyer.

This is Mercury Control. Astronaut John Glenn is in voice communications with the U.S.S. *Noa*; he has just advised the people on board the *Noa* that he will assist in removing a small pressure bulkhead so he can crawl up through the small upper neck of the spacecraft. This is Mercury Control.

We are still awaiting the report from the U.S.S. *Noa* that the Astronaut John Glenn has in fact come out of the Friendship 7 spacecraft. They are in voice communication, working together to make the arrangements for him to get out of the spacecraft. This is Mercury Control.

Astronaut John Glenn is still in contact with the members of the U.S.S. *Noa*, he is assisting in the egress by removing part of the instrument panel and a small pressure bulkhead in the upper portion of his spacecraft. Then he will have to push out the empty parachute canister and crawl up through the narrow upper neck of the spacecraft. This is Mercury Control.

Because of difficulties in clearing the way overhead in the upper neck of the spacecraft, crew members aboard the U.S.S. *Noa* have now decided to blow the side hatch and let John Glenn come out that side hatch.

The radio reports from the U.S.S. *Noë* indicate that the hatch is now blown clear; Astronaut John Glenn should be stepping out of the spacecraft any moment now.

A report from the U.S.S. *Noë* downrange indicates Mercury Astronaut John Glenn has left the Friendship 7 spacecraft. He is reported to be a hale and hearty astronaut after having successfully flown the U.S. first manned orbital flight. U.S. Astronaut John Glenn is on the deck of the U.S.S. *Noë*; is reported to be a hale and hearty astronaut after his history-making flight. This is Mercury Control.

When Astronaut John Glenn is out on the deck of the *Noë* and it becomes known that he is in excellent condition, simultaneously with this the Post Office Department has started the release of a commemorative 4-cent stamp to commemorate the occasion. As to news released, two different news releases and some pictures of the commemorative stamp will be available at the den where the pool material is released in a few moments.

The present plan for the Mercury Pool to go to a Mercury Control Center momentarily for a quick debriefing inside the control center, thereafter start our news conference in the tent at about 4:30 p.m.

The astronaut will receive a rather fast debriefing on the destroyer, get a quick medical check; in the meantime, now, the destroyer is proceeding toward Grand Turk Island. It is expected a rendezvous with the *Randolph* within about an hour. John Glenn will be transferred to the *Randolph* and will fly from there to Grand Turk. END.

The spacecraft has been set on the deck of the U.S.S. *Noë*. This is Mercury Control. We are still maintaining radio contact with the U.S.S. *Noë*; the spacecraft Friendship 7 is on the deck at 4 minutes after 3, a.m., this afternoon. Astronaut John reports "My condition is excellent." He is in continuous contact with the people on the ship. This is Mercury Control. Friendship 7 is resting on the deck of the U.S.S. *Noë* in the South Atlantic. Arrangements are now being made to let the astronaut crawl out the upper neck of the spacecraft onto the deck of the destroyer.

This is Mercury Control. Astronaut John Glenn is in voice communications with the U.S.S. *Noë*; he has just advised the people on board the *Noë* that he will assist in removing a small pressure bulkhead so he can crawl up through the small upper neck of the spacecraft. This is Mercury Control.

We are still awaiting the report from the U.S.S. *Noë* that the Astronaut John Glenn has in fact come out of the Friendship 7 spacecraft. They are in voice communication working together to make the arrangements for him to get out of the spacecraft. This is Mercury Control.

Astronaut John Glenn is still in contact with the members of the U.S.S. *Noë*; he is assisting in the effort by removing part of the instrument panel and a small pressure bulkhead in the upper portion of his spacecraft. Then he will have to push out the empty parachute canister and crawl up through the narrow upper neck of the spacecraft. This is Mercury Control.

Because of difficulties in clearing the way overhead in the upper back of the spacecraft crew members aboard the U.S.S. *Noë* have now decided to blow the hatch and let John Glenn come out that side hatch.

WILLIAMS. The weightlessness would be roughly three times the orbital.

NEWMAN. About four and three-quarter hours for the period of weightlessness. And the acceleration went up to a peak of about 8 G twice during launch and a little over 8 G during reentry.

Question. Was there any damage so far as you know from your observation—any damage to the capsule which caused it to land, getting out of it?

SEMPARD. No, there was no damage to the capsule. We were receiving continual reports through the relay which General Davis mentioned from the recovery ship here at the Cape, and so we were getting immediate information. We continued to indicate that there was no external damage to the capsule, including the landing system.

APPENDIX E

PRESIDENT KENNEDY'S STATEMENT, FEBRUARY 20, 1962

I know that I express the great happiness and thanksgiving of all of us that Colonel Glenn has completed his trip, and I know that this is particularly felt by Mrs. Glenn and his two children.

A few days ago Colonel Glenn came to the White House and visited me, and he is—as are the other astronauts—the kind of American of whom we are most proud.

Some years ago, as a Marine pilot, he raced the sun across this country—and lost. And today he won.

I also want to say a word for all those who participated with Colonel Glenn in Canaveral. They faced many disappointments and delays—the burdens upon them were great—but they kept their heads and they made a judgment, and I think their judgment has been vindicated.

We have a long way to go in this space race. We started late. But this is the new ocean, and I believe the United States must sail on it and be in a position second to none.

Some months ago I said that I hoped every American would serve his country. Today Colonel Glenn served his, and we all express our thanks to him.

Question. Did his condition was anything but excellent? In fact, I recall one comment that he said, "Now that I am getting used to it, it is quite comfortable." "I feel at home"—was more or less his comment.

WARR. I would like to second your comment about the fact we do not know—they have not released the data as to when Titov became ill. And we can only chip away at this thing. We say that John Glenn did not become ill or have any ill effects during this flight. I think it would be speculative to go beyond that today.

WILLIAMS. I think another speculation on this, in spite of the stories that Titov was sick; it is also reported that he carried out his flight quite well, and did the things he had to do. So the degree of illness, of nausea, we just don't know.

Question. I would like to address this to Mr. Williams, just to clear up this controlled flight in orbit. You indicated, Mr. Williams, it was at least an orbit and a half. Earlier reports from Johnny Powers indicated it might have run a little over two orbits. Would either of these establish an international record for the United States?

WILLIAMS. I don't know if there is a record for that sort of thing. FAI, of course, will get all information from this flight, and we will, naturally, lay claim to whatever record that was set.

APPENDIX E

I know that I explored the great happiness and tranquillity of all

CHICAGO, Ill. (UPI)—The Chicago Bulls have won their first NBA championship since 1991, defeating the Los Angeles Lakers 4-2 in the finals.

away by the time the speaker—or song leader—has finished.

Some years ago, as a Marine pilot, he raced the sun across the

Gang in Canada. The local man, who had many friends, and also

And they made a signment, and I think their signment has been laid—the burials upon them were great—but they kept their heads

We have a long way to go in this space race.

on it and be in a position to report to the United States on Friday morning.

his country. Today Colonel Glenn saved the land we all expect.

APPENDIX F

TRANSCRIPT OF MA-6 PRESS CONFERENCE COCOA BEACH, FLA.; FEBRUARY 20, 1962

PARTICIPANTS

Dr. Hugh L. Dryden, Deputy Administrator, NASA Headquarters.
Mr. D. Brainerd Holmes, Director, Office of Manned Space Flight,
NASA Headquarters.

Mr. Robert R. Gilruth, Director of Project Mercury, NASA Manned
Spacecraft Center.

Mr. Walter C. Williams, Mercury Operations Director, NASA
Manned Spacecraft Center.

Dr. Stanley White, Chief, Life Systems Division, NASA Manned
Spacecraft Center.

Maj. Gen. O. J. Ritland, Commander, Space Systems Division,
AFSC.

Maj. Gen. Leighton I. Davis, Commander, AMR, and DOD Repre-
sentative, Project Mercury.

Rear Adm. John L. Chew, Commander, Mercury Recovery Forces.
Astronaut Alan B. Shepard.

Narrator: Paul P. Haney, Project Mercury Information Manager.

HANEY. We would like to proceed now. Starting at the far end of
the table is Dr. Stanley C. White, Chief of the Life Systems Division,
Manned Spacecraft Center, NASA; Maj. Gen. O. J. Ritland, Com-
mander of the Space Systems Division, U.S. Air Force, Los Angeles;
Mr. Walter C. Williams, Mercury Operations Director, Manned Space-
craft Center; Mr. Robert Gilruth, Director of Project Mercury. To
Mr. Gilruth's left is Dr. Hugh Dryden, Deputy Administrator of
NASA. To his left is Mr. D. Brainerd Holmes; to his left Maj. Gen.
Leighton I. Davis, Department of Defense Representative to Project
Mercury, and commander of the Atlantic Missile Range; and to his
left is Rear Adm. John L. Chew, commander of the Mercury Recovery
Forces. At this end of the table is Astronaut Alan B. Shepard. Dr.
Dryden will open the remarks.

DRYDEN. This is a very historic day to which we have been looking
forward for a little more than 3 years, when the mission performed so
excellently today was only an idea in the minds of a few people, like
Bob Gilruth, and some of his associates. We have come a long way
in the 3 years. All I want to say is that this is just the beginning—
just the first step. Today, of course, is particularly John Glenn's day,
but it is the beginning of an enterprise—the exploration of space that
will go for a long time—and not too many years from now we will look
back at the Mercury capsule as we do on the Wright airplane. You
will think that this mission, which you have seen today, was a very
primitive kind of space mission. Now, the man who has the respon-
sibility at NASA at the top level to plan these missions for the future
is Brainerd Holmes, who is sitting at my left.

HOLMES. Thank you, Hugh. I was tremendously impressed with the effectiveness with which this program has been planned and in which the engineering was effected and carried out today. I think it is an excellent, major step in initiating our man-in-space program. A great deal of information was received in today's flight. Much of the information could not have been received if it were not for a man being on board. I think we have confirmed many of the plans and much of the engineering data in this very practical way by flying a man in this three-orbit mission. We will have more missions, more extensive and complicated missions. I think in closing, I feel this is really a great deal of testimony to the engineering effort of this particular team and to the engineering problems of the men working in space in the United States. And now to my left is Gen. Leighton I. Davis.

DAVIS. The DOD support for this project was quite extensive, of course—18,000 people, 15,000 of which were in the recovery portion, about which Admiral Chew will speak. I would like to address myself to the other units of the DOD which helped out. In addition to the ranges—Pacific Range, White Sands Missile Range, and the Atlantic Missile Range—of course, we had the Sea Air Rescue Forces around the country and Europe and Africa, the Pacific Air Force deployed, as well as the many medical officers from the three services who are assigned to support the project. The operation went very well from our viewpoint. I think some of the stations performed quite terrifically, particularly the Mercury Station at Muchea, which came out with the maximum amount of information on each pass. The links of communication were particularly effective. The voice of the astronaut from the capsule to the Indian Ocean ship, for instance, came back by single side band, and also from the Atlantic ship. Similarly, in the final phases of the recovery, there was a two shore relay by airplane, then through subcable and then up to our Mercury Control Center, which went very well, and speaks, more I think as tribute to a lot of practice and a lot of simulation in exercises of this type. I would like to pass the ball to Admiral Chew.

CHEW. I would simply like to remark that the relative simplicity with which the recovery was accomplished in no way showed the tremendous amount of work that had gone into the DOD team effort—the planning, the extensive preparations, the training of all the forces involved. Both Army, Navy, Air Force and Marines, and the fruition of the successful recovery, which of course entails location—and again in this particular case it was simple—because the spacecraft was sighted coming down just about 5 miles away from a destroyer, the first element then, of recovery, was simple. The second element—retrieval—was also simple, for in 21 minutes the capsule with John Glenn in it was on board the *Nea*, and I hope and presume that the third phase of recovery, which is delivery of the astronaut, will be accomplished without further ado. It has been my privilege to be associated with such a team. I will now pass it on to someone who probably doesn't need much introduction, Astronaut Alan Shepard.

SHEPARD. Thank you, Admiral. As a general comment I will say that a lot of people are very happy today, happy for a lot of reasons. For those of us who were directly connected with the flight were extremely pleased, particularly pleased, for the way that John

was able to perform, the way he was able to observe, and the way he was able to report. That is all I have to say at this moment.

HANEY. I think now we would like to call on Mr. Gilruth to speak for the mission directly.

GILRUTH. Ladies and gentlemen, needless to say I am very, very happy, and very, very proud of John Glenn and the entire Mercury team who pulled this mission off today. It was a very good flight and we got a tremendous amount of information about space from it. I would like to say that from where I sat, which was not in the main stream of the events of the people controlling this flight, but I had a very good view. I assure you—John Glenn performed all his test pilot functions very, very well. He was very sharp all through the flight. At no time acted as though he were in any other kind of a vehicle than a Marine Corps vehicle flying somewhere on some mission. He felt good and he retained his sense of humor, and it was a thoroughly impressive job.

I would like to pay tribute in a little bit more detail to all the various teams that were involved in this operation here today. First taking it in a sort of chronological order, the teams that checked out the spacecraft and checked it out while they were waiting so long for the weather to be right, but you see it finally did get right. I would also like to pay tribute to the booster people who repaired and got ready that wonderful booster you shot away, which was just about exactly perfect.

I would like to pay tribute to the weatherman who stuck with it and finally got the weather right, and all the people who are responsible for the planning. As Admiral Chew mentioned, the recovery teams—it is not easy to sit out there day after day with the seas as they were. I am sure I am going to miss some of the very important elements of this team, and if I do, I hope Walt Williams will fill in for me. Before I relinquish my spot here, I would like to say a word of tribute for Walt Williams and his operations team. He has always been terrific in these missions, and has never given any indication of getting rattled and makes the right decisions, and Walt himself, I think, deserves a large amount of credit for pulling this team together, training it, and training with them, with himself and Cris Kraft and the rest of those wonderful people. And now I would like to ask Walt Williams to say how it looks from where he sat.

WILLIAMS. After that, I don't know what to say. Thanks a lot, Bob. Rather than going into any of the real details of the flight today, I think I would like to talk about a few of the significant things I feel we did accomplish. We not only put an American man in space, we showed very definitely how well a man can work in space. We had numerous problems along the way, which I'm sure were relayed to you, that had we not had a man aboard, the flight would not have come out nearly so well. It surely would not have gone three rounds. There were times when the pilot did take over, and the automatic controls which control the capsule quite well through much of the flight. It was reassuring when there were instrumentation questions that the pilot would come back and answer and help, and as Alan pointed out, he sure did a beautiful job today. I have watched many a test pilot at work, and I have never seen a better job anywhere than John Glenn did today.

I think one point that might be confirmed was this matter of why we left the retro pack on during reentry. This is quite simple. We had the choice of whether to believe we had a faulty micro switch or a faulty relay. A faulty micro switch had given us a false indication that the heat shield had separated from the capsule as it does at landing. I think most of you are familiar with the landing bag where the heat shield is dropped down from the capsule. There was every indication that this had occurred. We also knew the retro packs and its straps would hold the heat shield in place until fired and jettisoned. On the other hand, as I say, this could have been just a faulty indication because of the micro switch. On the other hand we could have had a relay go bad which had fired the squib which would have disengaged the heat shield from the capsule. And reentry with the heat shield detached would have been a catastrophe. So our choice was to retain the retro pack, after firing, and take advantage of the straps of the retro pack to hold the heat shield in place until we had enough aerodynamic force on so there would be no possibility of the heat shield dropping off.

I don't know if this is completely clear but this is the problem we were faced with. We felt we were much better off coming in with the retro pack on, knowing sooner or later that if we did it would, the straps holding it, would melt away, but we also knew it would not melt away till there was sufficient force against the heat shield to hold it in place. I think, I say I think, Al, you may want to confirm this from your discussions that actually we had a false indication, that actually the heat shield did not release from the capsule until after the main parachute deployment, as it would be expected to. However, we did not know this at the time we got into trouble. At least, at the time we had this indication, and had to perform our reentry and that was the reason for that.

Now this did mean that this interrupted the capsule sequence and John had to take over and do some controlling during reentry. And he did a good job of this.

I don't know. I guess maybe at times I get a little emotional about these things. Right now I feel like the day school let out.

RITLAND. After following through the mission today, it seems like the launch phase happened a long time ago—so many things have happened. It was certainly a perfectly beautiful shot as all of you will attest to who were here today at the Cape. But more importantly, from a scientific and technical point of view it was still more beautiful and wonderful.

To those of us that monitored the launch phase from Central Control and watched the plot of the missile as it rose into the atmosphere and then out of the atmosphere it followed a direct and positive line on a preplot. We did have one concern, at about 150 seconds the pen bobbled a little bit and had no bearing on what was happening in space. It was the pen that tracks the plot.

Question. How many seconds?

RITLAND. At around 150 seconds. Anyway, this seemed like a very long time. But I feel that this shot today, from a booster point of view, just didn't happen. It was planned at least 3 years ago by the people in the Air Force, and our contractors, General Dynamics, Rocketdyne, General Electric, and Burroughs.

Question. Was that at 150 seconds?

RITLAND. About 150 seconds.

Question. The missile didn't wobble at all? It was just a pen on the plot chart?

RITLAND. Not a bit. It was just a pen on the plot. Continuing, we planned for this type of an operation over 3 years ago. We set up special procedures. We selected special components for the missile and we established special procedures for acceptance and quality control. We demanded that the same crews would stay on this flight so they would be extremely experienced. I feel certain that it was this tremendous effort by all of the people responsible for the booster operation that attained this success today, and we certainly are proud of every one of our people who participated in this area.

WHITE. I would like to turn from the mechanics and say hey to something that Al Shepard said. I think as I started putting my notes together, I said it was the day and it was all John's because of two things as far as our point of view. First of all, he flew, as far as we can see from the data obtained, completely normal, as normal as can be and even more normal than most expected flights. In addition to this we had a real bonanza by getting good data from all the sensors that were hooked to John and also to the environmental system that would give us a good correlation of how the spacecraft and its environments were working. Thirdly, we were able to, in the early look at data and reports coming in from the station, follow along with the proposed flight plan and the tests we had put on to try to get at some of the questions of the Titov problems and at least in the early, very early looks, it looked as if John had no difficulty with these and the reports coming from these stations and also the voice checks coming from John. We asked him and queried him about it and he was very complimentary to the fact that the tests didn't faze him a bit. I must admit the accelerations were very nominal during launch and we were quite pleased to hear John talking right through both BECO and SECO. He was completely in command throughout the entire thing so far as listening to him report, and I also say that he kept his sense of humor. I thought it was very well and it was very refreshing around the network.

HANEY. Thank you. If you have questions, please address them to specific panelists.

Question. Dr. Dryden, obviously this has shortened the gap in our race with the Russians and I wonder if you can go into that a little more in detail as to how much it has shortened the gap and when that gap may not exist?

DRYDEN. This is very difficult to answer because our Russian friends have been silent for several months now and have still not produced the steps forward in their capabilities that may lie ahead. I think it is in the hands of Brainerd, Bob Gilruth, and Wernher von Braun—when we obtain the Saturn vehicle, C-1 and the advanced Saturns to determine whether in their hands and in the hands of what the Russians do to decide whether we, in fact, have closed the gap. We have orbited a man three times around the earth in 3 years from the time it was an idea.

Question. I wonder if Dr. White could tell us a little bit more in detail what the pilot's tasks were—how they were carried on—the eating, the drinking, the exercise, and the picture taking and so on.

WHITE. First of all, I would like to say the one big task that he carried out was the one he did so well—that of control. Now superimposed upon this, during the flight plan, there were a series of tests which got at the eating and drinking that was mentioned. These were phased so that they would be repeated with elapsing segments—each orbit. It would allow him to try both solid malt-type pills and also some of the tube feeds—liquids, semiliquids, and paste—as a way of finding out if the upset of the stomach would be the problem that was associated with Titov. We also programed, with the same periodicity, the scheduling of head motions, which would normally get at the inner ear as a trigger mechanism of setting off the nausea that Cosmonaut Titov described. During the first two orbits he was able to follow this program very, very closely. During the third orbit he had to defer some of these to stay with the work that was accumulating for him to do on the automatic control system. We felt this is not a real loss because he obviously was demonstrating a performance which compensated for the small experiments which were scheduled.

Question. I guess this should be directed to Walt Williams. I don't mean to beat this bobbling pen to death, but did it cause any momentary consideration of possibly having to destroy the booster?

WILLIAMS. Oh no, as General Ritland pointed out, this had nothing to do with the booster. This is purely a display board which wiggles.

Question. I never should have mentioned it.

WILLIAMS. I can say that the plot board in Mercury Control today showed the smoothest tracking data that I think we have seen on any of our missions. There was very little noise in the data—it was very beautiful.

Question. Will the admiral give us some more time details on recovery—the 21 minutes to the time on board the destroyer is from what point?

CHEW. The 21 minutes were taken from the time the capsule landed in the water until it was on board.

HANEY. I believe the times were 47 and 04.

CHEW. That is correct. 47 and 04.

Question. I would like to find out two things. One is to Walt Williams—what was the difficulty that turned the fuel light red sometime during the second orbit and was this a consideration at one point of perhaps terminating the flight at that point? Secondly, why did the astronaut spend so much time trying to get out the top on board the destroyer rather than blowing the hatch right away?

WILLIAMS. I can answer only part of that. I think I indicated we were having difficulty with the automatic system. We were using excessive fuel on automatic system. Again, one of the small thrusters malfunctioned. We had this trouble before. At this time, rather than voiding the mission or not going on, we had a pilot aboard. I think I pointed this out at the time of the Enos shot, and this was the very same thing. This time we had a man aboard and we did not have to worry about depleting the automatic system because he could use the manual system and had sufficient fuel to carry out the mission. And we did it on this basis.

Now as to why he did not come out the top hatch—came out the side instead, I will have to refer to Al. He talked to John, I have not. Do you have any comment, Al?

SHEPARD. Yes, and before I comment on that—to amplify the answer to the first question a little bit—the warning light which we use on the fuel system is actually set to come out at a fairly high value. In this particular case, it comes on with only 35 percent of the fuel used or 65 percent remaining. It is just a warning signal to indicate that the fuel is being used out of that system. For example, on that tank we consider 35 percent as being the absolute minimum. So you see we have given ourselves a great deal of margin there. And secondly, with respect to coming out of the capsule, the most desirable way to keep the capsule intact is not to blow the hatch because there is some deformation of the hatch itself during explosion. Therefore, we had decided ahead of time that if it was at all possible that he would come out through the top. If he was having a little difficulty in getting out fairly soon to go ahead and blow the hatch. That is the reason the decision was made.

Question: This I believe is to either Mr. Williams or to Mr. Gilruth. You recall at the time of the MA-5 Enos flight that there was trouble with the steering mechanism in the capsule and there was overheating in the cabin. At that time it was said that if either of the eventualities had occurred with a man on board he could have corrected them. Now they both did, and man did correct them. My question is this, whether this does not indicate to you some sort of necessity for a rather drastic revision of your steering mechanism in this capsule?

WILLIAMS. No; I don't think so. I would say refinements, yes, but not drastic revision. I wish I had one of them here to show you. This small, one-pound thruster is a delicate piece of jewelry which is also used with a liquid, and this is a problem. The orifices are very small that could be easily blocked.

Question: I would like to ask Brainerd Holmes if today's achievement will allow us to accelerate Mercury and our follow-on programs such as Gemini or Apollo?

HOLMES. I think the answer is "No." We are planning very carefully to schedule ahead more extended Mercury flights, for additional Mercury flights like this—three orbits, to the extent of one and then follow hard on the heels of that with Gemini and Apollo. But we planned for success today, and we are planning and laying out our organization for our entire program for maximum acceleration and speed. I think it would not be candid or frank or honest to say this will speed it up. If we hadn't done this today it would have been a setback for us.

Question: You will stick then to the three other three-orbit Mercury flights planned for this year in preference to the two 18 orbit flights?

HOLMES. We will have further 3 orbit flights, and toward the end of the year and the first part of next year go into 18-orbit flights. And hard on the heels of that Gemini and Apollo flights.

Question. Mr. Williams, could you indicate roughly how much of the 4 hours and 50 minutes were controlled flight by Glenn and how much was on the automatic system; and the second part of the question—did the fact that the pilot was called upon—how much of the flight was automatic and how much was manual? Or fly by wire? And did the fact the pilot had to take over interfere with the planned weather or scientific or astronomical observations?

WILLIAMS. Well, I will answer those in reverse order. I think Dr. White covered this in that I don't feel it really did interfere with the

other things he had to do, and really he was up for quite a long time. And things, once in orbit, I don't feel happen that quickly. He can't control the machine and still carry out his tasks. John Glenn, like Al or any of our other astronauts, are used to flying a machine and making observations at the same time. I cannot give you any exact number on the amount of manual flying versus automatic, but I think—and again I have to say I think—that the manual flying was in excess of 50 percent.

WHITE. Actually Walt, I think you should note to them that in this last orbit much of the checking and work he was doing actually was contributing to the very type of thing he would be doing anyway—namely looking out the window, checking horizons and this type of thing—so it complemented each other. He just had another reason for doing it.

Question. Could Admiral Chew tell us where Glenn precisely landed in relation to what large body of land, for instance Bermuda or Puerto Rico?

CHEW. About 166 miles due east of Grand Turk. General Davis very kindly corrected me. I think it is about 150 nautical and 166 statute.

HANEY. Admiral Chew, you might want to add—do you have any word on the disposition of John Glenn as to his movements? Did you have any late word before you left the Cape?

CHEW. I have no late word other than he will be transferred to the carrier *Randolph* and then flown to the island.

HANEY. Will that be this evening, or has an estimate been put on it?

CHEW. No. When I left the control room there was not an indication of precisely what time he would leave the carrier.

WILLIAMS. Admiral Chew, I believe I just got some hand signals here that he was going to go aboard the *Randolph* in 5 minutes.

Question. We have been told around here that Vice President Johnson is going down to the island to escort Glenn here and that the President is coming up here Friday. Is there any confirmation to that?

HANEY. There was an announcement at the White House at approximately 15 minutes before this meeting began that the President does plan to come town here Friday morning. We will have firmer times, sites, and agenda on this probably tomorrow morning.

Question. I have a few other questions on vital statistics. Can you tell us the time that Colonel Glenn was weightless? Can you tell us the number of miles that he flew today? Also the maximum G force?

HANEY. The number of miles he flew and max G. Alan, do you have any figures on that?

SHEPARD. The computers are at work. The apogee and perigee, Walt?

WILLIAMS. I have those—141.2 nautical miles was the apogee. Perigee was 86.84 nautical miles. Period of orbit was 88 minutes 29 seconds. The inclination of the orbit was 32.54 degrees. The velocity of insertion was 25,728 feet per second, which was very close to what we planned it to be.

GILRUTH. In response to the other question about how far did he fly, I believe the figure was 81,000 miles—give or take a few miles. Quite a bit to put on your car in one afternoon.

WILLIAMS. The weightlessness would be roughly three times the orbital.

SHEPARD. About four and three-quarter hours for the period of weightlessness. And the acceleration went up to a peak of about 8 G twice during launch and a little over 8 G during reentry.

Question. Was there any damage so far as you know from your conversation—any damage to the capsule which caused it to land, getting out of it?

SHEPARD. No, there was no damage to the capsule. We were receiving continual reports through the relay which General Davis mentioned from the recovery ship here at the Cape, and so we were getting immediate information. And they continued to indicate that there was no external damage visible in the capsule, including the landing system. The impact bag system was also intact.

Question. Mr. Williams, I would like to ask about the pictures that Colonel Glenn was to take in orbit. Did he take pictures in orbit?

WILLIAMS. Yes, he did.

Question. What kind of film did he use, sir? Did he use color film, black and white?

WILLIAMS. He used color. He used black and white.

SHEPARD. Yes, he used both color and black and white.

WILLIAMS. I recall at one time during the flight he was putting the fourth roll of film in the camera, but I don't remember now just when it was.

Question. Will we be able to get these pictures?

WILLIAMS. Sure.

Question. And No. 2, please. Major Titov reported illness while aloft starting almost immediately as I recall. The fact that Colonel Glenn reported no such illness indicates what to you? That is it a matter of individuality? Or we train our men better, or what?

WILLIAMS. Well, I could answer that almost any way I see fit. I don't know very much about the Titov flight, except this report of nausea, which, as I recall, occurred after 8 hours—not immediately. If you recall, Gagarin reported no difficulty. John Glenn at no time today indicated that his condition was anything but excellent. In fact, I recall one comment that he said, "Now that I am getting used to it, it is quite comfortable." "I feel at home"—was more or less his comment.

WHITE. I would like to second your comment about the fact we do not know—they have not released the data as to when Titov became ill. And we can only chip away at this thing. We say that John Glenn did not become ill or have any ill effects during this flight. I think it would be speculative to go beyond that today.

WILLIAMS. I think another speculation on this, in spite of the stories that Titov was sick, it is also reported that he carried out his flight quite well, and did the things he had to do. So the degree of illness, of nausea, we just don't know.

Question. I would like to address this to Mr. Williams, just to clear up this controlled flight in orbit. You indicated, Mr. Williams, it was at least an orbit and a half. Earlier reports from Johnny Powers indicated it might have run a little over two orbits. Would either of these establish an international record for the United States?

WILLIAMS. I don't know if there is a record for that sort of thing. FAI, of course, will get all information from this flight, and we will, naturally, lay claim to whatever record that was set.

DRYDEN. There are three efficient observers here from the FAI, including the president, Mr. L. A. France.

Question. Dr. White, could you elaborate on the effects of weightlessness on Colonel Glenn—his response, his reaction or comments to weightlessness?

WHITE. I can summarize it very well. He said that there were no adverse effects, and as far as the data that we have seen and had a chance to look at, we agree.

HANEY. Do you recall, Dr. White, his comment when the retros fired?

WHITE. He said he thought at that time, I think it was most impressive, was changing the status, he said he felt like he was going back to Hawaii for a moment there.

Question. I would like to ask Mr. Gilruth, about the actual reentry in which the retro pack was attached to the shield. Did this increase the problem of getting back into the atmosphere? Of controlling the spacecraft?

GILRUTH. No, I think it would have very little effect. Actually the retro pack would not stay on during the entire reentry because the metal straps that retain it are thin metal and probably would burn away by the time the spacecraft—or long before it reached the maximum heating condition, so we would expect it to have a very little or small effect on the reentry heating.

Question. This is for Mr. Williams. Do you have any idea what those luminous particles are which Glenn noticed?

WILLIAMS. No, I do not.

Question. When do you expect John Glenn back here, and when will we have a press conference with him? When will we know if the President is coming?

HANEY. When can we expect, I believe, John back directly. Walt, Friday morning, at this point, would you estimate?

GILRUTH. Well, I think it is a little premature to say exactly when. I certainly don't know myself.

HANEY. If you will check with the news center tomorrow we will probably have more definitive information at that time.

Question. Do you have a maximum heat load during reentry?

GILRUTH. Do you mean B.t.u.'s per square foot per second max? I have forgotten them.

Question. Temperature?

GILRUTH. Temperature of what?

Question. Of the heat shield? How hot did it get?

GILRUTH. Well, the melting glass, I think, is supposed to be somewhere between three and four thousand, not glass, but ablative surface. But the air, as you know, is very, very much hotter than that.

Question. I would like to ask Mr. Gilruth to explain whether or not it is true that Colonel Glenn suffered a period of blackout upon landing. Is that true or untrue?

GILRUTH. It is untrue, to my best knowledge.

SHEPARD. Perhaps I could help clarify that. There was some confusion with respect to blackout. John reported blackout, indeed, but it had to do with blackout of communications as a result of ionization during the reentry. As you may know, communications are lost during part of the reentry, and this was the blackout to which

he referred. He suffered no blackout himself. As a matter of fact, performed very well during the reentry.

Question. Could Dr. White give us any kind of idea what kind of changes took place in Colonel Glenn's respiration rate and his heart-beat during the weightlessness, if any changes?

WHITE. Well, as you would expect, the rate went up by a factor of about a half—actually a little less than a half, during the launch. By the time he had been weightless for approximately 20 minutes, he had returned to almost prelaunch values. Now, depending on the workload, and the activity, and exercising and things of this type he was doing, the pulse stayed about prelaunch and nominal values. Blood pressure also stayed very close to—as some of the data we looked at—stayed very close to the normal, on the pad data. We check under exercise, where we gave him a chance to do a certain given amount of exercise we had checked against here on the ground, and looked at this again, and we saw no marked change in the reports we have gotten to date, that the exercise tolerance, or the changes that would be physiological expected with prolonged weightlessness did not occur, as far as we can see on the preliminary data.

Question. I believe we were told at one point that the temperature of the cabin was 105 degrees, or 108, something like that. That seems pretty hot to me. Why did it get that warm? And was his suit—did he feel that warmth or was he insulated from it?

WILLIAMS. He was insulated from it, in that he has his own cooling system within the suit.

WHITE. First of all, you were right in that he did get to this height, and what you saw was cyclic, day-night cycle that occurred in the cabin of anywhere about 5 to 10 degrees, it looks like. In other words, when the night side would come, it would start cooling down, and when the light side would come, the heating on the outside would add to the heat on the inside, and it would start going up. He was insulated, and as far as his suit temperature was concerned, he was throttling this, and actually kept it fairly well turned down, in other words, to stop or to reduce the amount of the evaporative water going through his suit circuit. So he was maintaining himself comfortably and he reported this consistently around the flight, all the way through the flight, until after reentry, and the only time he said it was kind of hot in there, so he was well insulated, even though the temperature of the cabin was running maybe 20 to 30 degrees higher than his suit.

Question. From the information you have on hand, how would you judge, percentagewise, the success of the mission?

WILLIAMS. Well, I would say that when John Glenn stepped out on the deck of the destroyer, the mission was 100 percent a success.

Question. Will Deke Slayton be the next astronaut and can you give us some idea of the picture?

GILBERT. Well, I think our next team—Deke Slayton is a fine pilot with Walter Schirra as the backup and Gus Grissom as third man or anchor man, such as Al Shepard was on this flight to John Glenn and Scott Carpenter. We will select additional crews in the same manner as we have in the past, for future flights. We have not done it at this time.

Question. I would like to know if the pilot did use the little flash-lights on the tips of his gloves, since he has asked for them?

WILLIAMS. I don't think he mentioned them. But I imagine he did. He was planning to.

SHEPARD. Yes, he did, very effectively.

Question. Due to the difficulty of Colonel Glenn getting out of the top of the capsule, is there going to be any change in the exit next time? It was to be programed for him to get out while he was still at sea. He had trouble even with outside help. What was the cause of this and what will you do next time?

GILRUTH. Don't you think we ought to have a chance to talk to John and look at the capsule and maybe get a little sleep before we have to answer all these questions?

HANEY. On that happy note, I think we will thank you for your many excellent questions. These gentlemen have been up, many of them, all night long and some of them have to catch planes at 7 to get back north. Thank you very much.

Wright: First of all, you were right in that he did get to this height, and what you saw was cyclic, day-night cycle that occurred in the cabin of anywhere about 5 to 10 degrees. In other words, when the night side would come, it would start cooling down, and when the light side would come, the heating on the outside would add to the heat on the inside, and it would start going up. He was insulated, and as far as his suit temperature was concerned, he was insulated, and actually kept it fairly well turned down, in other words, so stop or to reduce the amount of the evaporative water going through his suit circuit. So he was maintaining himself comfortably and he reported this consistently around the flight, all the way through the flight, with after reports, and the only time he said it was kind of hot in there, so he was well insulated, even though the temperature of the cabin was running maybe 20 to 30 degrees higher and his suit.

Question: From the information you have on hand, how would you indicate your estimate of the success of the mission?

WILLIAMS: Well, I would say that when John Glenn stepped out on the deck of the destroyer, the mission was 100 percent a success.

Question: Will Duke Clayton be the next astronaut and can you give us some idea of the future?

APPENDIX G

TRANSCRIPT OF COLONEL GLENN'S PRESS CONFERENCE, CAPE CANAVERAL, FLORIDA, FEBRUARY 24, 1962

Mr. WEBB. Ladies and gentlemen, shortly less than 9 months ago when Mercury had made its first demonstration of the validity of the concept of the manned machine spacecraft-booster combination, using what we had in the Nation at that time, it was my great pleasure as the new Administrator to meet you in Washington and arrange for Commander Alan Shepard to tell you of his first flight proving this system.

Today we are at another phase. In the meantime, we have had a second proof by Grissom's flight. Today we have opportunity under the policy of this Nation of rapid and accurate reporting of the features of this program to introduce the two men who have been most responsible in this specific instance—Mr. Robert R. Gilruth, as you know the Director of Project Mercury, received the Distinguished National Award from the President of the United States today, as did John Glenn. So here they are and I believe Bob Gilruth wants to say a word before we start.

Mr. GILRUTH. Well, ladies and gentlemen, this is a tremendous occasion for me and I'm sure in a very short moment John will be speaking for himself. This is John's day. It's more than a day, I'm sure. I just want to say before I lose my brief spot here that the part I played in today's program—the things that flash over my mind—flashed over my mind when the ceremony was going on were filled with the names of my key people like Walter Williams, Max Le Jay, Tug Matthews—I could go on a great long list.

These are the fellows that really on the planning and engineering side have done this job and I was very very proud and very happy to be a representative of the project this morning.

Now I think you're all anxiously waiting to hear from the man who really was the anchor man on this team and really pulled this job off and so it's my very, very great honor to pass this microphone over to Colonel John Glenn.

Colonel GLENN. Well, I know you're probably anxious to hear about what things were like on the flight, so we might as well get started on that. I can make a few brief remarks concerning some of the major phases of it, and then we can field some questions here if some of you have some specific questions.

First off, it was a quite a day. I don't know what you can say in which you see four beautiful sunsets in one day, but it's pretty interesting—three in orbit and one on the surface after I was back aboard the ship. But this is a little unusual, I think.

We were asked some questions before the flight about how the delays affected our readiness, and although I didn't read some of the writeups I understand there were some considerably gross misconceptions put about how the delays affected our state of readiness.

I think Scott Carpenter put it in probably the best light when he said I was the most fortunate one around with this excitement going on and all of the business around the Cape area and all the preparation, because all I had to do at that time was sit back and just hone the edge a little more and keep in good shape. And I think that put it about in its proper light.

I certainly did not experience any of the terrible subliminal impressions or hallucinations that I was supposed to be receiving from all of this preflight activity and the cancellations.

We had had our holds, of course, on previous launching attempts; on the 20th [of February] though, that morning as the weather started to clear and we could see the big blue holes coming up I really felt that we were in a real go condition at that time because the booster was ready and everyone I think sort of gets go-fever when you get all conditions set right. I felt that, I think everyone was excited that morning.

The power flight phase booster worked perfectly. Obviously it did from the fact that we came out within a very few feet per second of the velocity that we wanted and were shooting of course for velocities of a little over 25,000 feet per second and when you come out within just a few feet per second at that speed, this is very accurate control. It was a good insurgence.

I think the best words I have just about heard in my life were, you have a seven orbit capability, from Al Shepard here when he gave the go to me from the capsule communicators position. That was a very welcome sound.

I don't want to go into a lot of details on the launch. I don't think they're necessary. I think all that's been pretty well covered from what I've seen in the papers.

As to our—after insertion then as to the effect of zero-G. This of course is one of the big things that we have wondered about through the early phases of the program, wondering what effect zero-G would have.

This puts us into a new environment that we have had no experience or limited experience with before in airplanes. We extended this realm of weightlessness, of course, during the Redstone shots that Al and Gus had, and we're extending it further here and I'm very happy to report that there just was no ill effect at all that I got from zero g. It was very pleasant as a matter of fact. We had no tendency to particularly overreach switches or have any trouble with the controls as a result of zero g. It was indeed a very, very pleasant experience.

Someone told me last night after I had been talking so enthusiastically about this it sounds like I was an addict to it, and I think I probably am; it was a wonderful feeling.

It was thought that over a period of time we might experience some ill effects from it in the way of nausea or disorientation, but there were none of these effects whatsoever.

No problem keeping oriented under zero g. I tried different head movements to see whether with certain head movements and combinations of head movements we would get any discomfort and nausea. We did not experience any of these at all, and these wound up with some rather violent head motions in roll, pitch and yaw to see if we were going to induce any abnormal feelings. We did not.

It was a very pleasant experience all the way through.

Some of the things that happened under zero g. sort of demonstrated how fast, though, a human being adapts to this situation.

I recalled last night when we were discussing some of these things the fact that I had had this little hand camera once, and I had taken a picture and I wanted to do something with a switch immediately.

And it just seemed natural at that time, after I'd been weightless for, I guess, it was a half hour or forty-five minutes, I got acclimated to this rapidly enough, and it just seemed perfectly natural, rather than put the camera away, I just put it out in midair and let go of it and went ahead with the switch position here and reached back for the camera and went on with the work.

And I remembered thinking afterwards that we were treating this pretty blasé at the time here. I think it demonstrated the point I'm making here is that I think we all adapt very, very rapidly to these new situations.

Much more rapidly maybe than even those of us who have been trained for this for 3 years would have believed possible. But it seemed just a natural thing to do, and if you were just letting go of something for a minute, why you'd put it there and let go of it and go back to it when you got time.

Under the zero g. condition, of course, it would be easy to lose different items, have them float away and get out of reach someplace. As far as I know, there was only one item that got lost and that was a little can of film that I got out and was going to put into the camera.

And I let it slip out of my fingers and went to grab for it, and instead of clamping onto it I batted it and it went sailing off around behind the instrument panel and that was the last I saw of it. I don't know where it went.

The eating experiment:

We had planned to do some of that. We had tried this before on weightless flights in airplanes, simulating weightlessness for a minute or so, and it hadn't appeared to be any big problem. However, we wanted to try it.

And I did. I had one tube of food that was squeezed into my mouth out of the tube. This presented no problems swallowing or getting it down at all.

I think the only restriction probably to food will be that it not be particularly crumbly like cookies, with a lot of little particles to them that might break off, because you wouldn't be able to get all these back unless you had a butterfly net of some kind, I guess.

As long as the food is solid you can hold onto it and can get it into your mouth, and then from that point on there appears to be no problem. It's all positive action. Your tongue forces it back in the throat and you swallow normally and it's all a positive displacement machine all the way through.

Speed sensation:

I've been asked repeatedly since the flight about what sensation of speed.

Speed, of course, is relative. If you're in a complete—if you have nothing to refer to you could be going almost any speed and you wouldn't have any sensation of this.

I think the nearest I can come to it is: most of you have flown in jet airplanes at 30,000 feet or so. And I think the feeling of speed is about the same as flying in an airliner, such as that, and looking

down at clouds say, maybe at heights of 10,000 feet below you, if you're at 30 (thousand), say.

I think the speed with which the ground goes out from you—just the sensation of speed you have from orbital altitudes—would be pretty close to that same speed.

It's difficult to describe the speed sensation when you have nothing to relate it to, but I think that's probably the closest we can come to it.

It was very noticeable that over a good part of our track there were clouds of one type or another that obscured some of the areas we wanted to look at. Part of the western United States, down across northern Mexico—almost the whole Pacific—was covered by one type cloud or another.

Of course coming down around Australia, Australia was always in the dark, so we couldn't—never could see Australia, although we could see lights from the city of Perth and the cities around Perth, too.

The sunsets are probably the most impressive thing that you would see in orbital flight. These are of very brilliantly colored hue and the colors stretch out—way out—from the sun to the horizon.

The horizon stays light for, I would estimate, some 4 to 5 minutes after sunset, which I found rather surprising because I thought darkness would come on much more rapidly than that.

I thought it would be just a matter of maybe a minute after the sun went down, but apparently there's quite a bit of light curving around through the atmosphere and that keeps the horizon very visible for a period of some 5 minutes or so.

And this would bring us around to a sunrise. This turned into a pretty interesting area each time around, I think, as most of you are aware.

At the first light of sunrise—the first sunrise I came to—I was still faced back toward the direction in which I had come from with normal orbit attitude.

And just as the first rays of sun came up onto the capsule I had glanced back down inside to check some instruments and do something. When I glanced back out my initial reaction was that I was looking out into a complete star field—that the capsule had probably gone up while I wasn't looking out the window and that I was looking into nothing but a new star field.

But this wasn't the case, because a lot of the little things that I thought initially were stars were actually a bright yellowish-green about the size and intensity as looking at a firefly on a real dark night.

These little particles that were outside the capsule were, I would estimate, some 6 to 10 feet apart and there were literally thousands of them.

As far as I could look off to each side I could see them. I could see them back along the path. Later on I turned around so that I was facing the direction from which they appeared to be coming, and although in that direction, toward the bright sunlight of the dawn, most of them disappeared, you still could see a few of them coming toward the capsule.

I was moving very slowly through this field. I estimated that my velocity through this field was some 3 to 5 miles per hour. They did not appear to be emanating from the capsule. They appeared to have even distribution across on each side of the capsule.

I thought of two things that they might be initially. One was the cloud of needles that the Air Force put up some time ago and that appears to have disappeared somewhere.

I thought we had suddenly found them again. But they didn't look like that. They didn't look like they had any length to them at all.

The other thing I thought was perhaps—as we use our hydrogen peroxide jets, the hydrogen peroxide decomposes into steam and oxygen and comes out under high heat and pressure—and I thought perhaps that water vapor was then turning to little snowflakes and that the luminous light from the sun was causing them to fluoresce for some reason or other.

But when I worked the thrusters on the capsule this did not appear to be causing any snowflakes or anything like it at all.

So all I can say about these is I observed them, I saw them for about—from the first light of sun through a period of some 3½, 4 minutes, that time period, made close observation of them.

Occasionally one would come drifting up by the capsule window very close in the shade from the sun, and at that time they would look like very small white particles. And they would vary in size probably from maybe pinhead size to something say about three-eighths of an inch in diameter, of that order.

There are numerous things that some of the people are thinking about and looking into, but I have no theory myself except we observed them. We saw it on all three orbits about the same length of time at each sunrise. They were very luminous, a yellowish-green color and as George Rapp, our psychiatrist, listened to this he said:

"What did they say, John?"

We had some problems during the flight. The automatic stabilization and control system was causing some difficulty. It didn't appear to be correcting up the way it should.

I was able to use the manual controls during that period, and this appeared to—didn't cause any trouble at all. It seemed very natural to take over manual control after all of the trainer work was done. Trainer simulations, incidentally, were very, very close to the orbital control situation.

This was particularly true in the fly-by-wire mood (mode) where we control through the automatic structures. When we started having this problem at the end of the first orbit, I was largely on manual control from there on until the end of the flight.

The other observations we had planned to make had to go by the board while I tried to work out the control system problems. And we spent most of the last two orbits working on this, making some other observations, but largely concentrating, probably 90 percent of the time, on the control system.

Ground, as most of you probably know, the ground telemetry receivers had picked up an impulse that we possibly had a loose heat shield and, for that reason, it was deemed advisable to keep the retropackage encased during reentry so that it would go ahead and burn off. But by that time we would be in a high enough aerodynamic burst field to keep the heat shield in place in case it was, in fact, loose.

This made pretty spectacular reentry from the capsule standpoint because, as the retropack, as I retained the retropackage and entered into the first part of the high heat area of the reentry, the straps on

the retropack broke loose and I felt a bump on the capsule and thought that the retropackage had jettisoned as it was supposed to do.

Apparently this was not true, but I thought so at the time. As it went on into the higher heat belt, this glow picked up outside the capsule to sort of a bright orange glow outside the window.

It became apparent that something was tearing up on the heat shield end of the capsule, because there were large pieces from anywhere—pieces as big as the end of your finger to pieces probably 7 or 8 inches in diameter were breaking off and falling off the edge of the capsule and coming back up past the window and were flaming very brightly.

You could see the fire and the glow from them as they would come up back past the window.

Well, this, obviously, was the retropackage tearing up and breaking off as we knew it would if it had been retained. I thought at that time, however, that the retropackage had already been jettisoned.

So there were some moments of doubt there as to whether the heat shield had been damaged and whether it might be tearing up itself. And this could have been a bad day all the way around if that had been the case.

But it was very spectacular looking out into this orange glow outside the window—bright orange glow—and seeing these big flaming chunks go back along the flight path.

I understand there was some misconception also when we referred to this term, "blackout," during reentry. And I was questioned aboard ship as to how I had survived the blackout and when I regained consciousness, and a few things like this. And this was—when we referred to a blackout during reentry, a communications blackout is what we were referring to in this case.

And we probably should reterm this a "comloss," or something like that, so that we don't confuse it with a blackout of the astronaut involved.

This is due to high ionization around the capsule and makes it impossible for the radio frequencies that we're using to get in and out from the capsule.

G's during reentry got up to about 8. Parachute functioned in completely normal fashion and that's probably the prettiest little old sight that you ever saw in your life—to look out the window and see that parachute.

I remember Al Shepard making some comments about that after his flight about how pretty that parachute was, and I concur. That's just about as pretty as anything you can see at that point.

The capsule was pretty warm after reentry—very hot, in fact—and it was getting very warm inside. I was sweating rather profusely when I came down and when I landed. So I remained as still as I could in the capsule, trying to add as little heat load to it as I possibly could. The destroyer Noa was close by and had me spotted and came over and made an excellent pickup of the capsule.

It came aboard, and at that time I had been heated up enough and had been sweating very profusely long enough that I decided after taking the panel—the right side of the panel—down, preparing the egress out through the top, I decided at that time, since we were already on deck, that it was hardly worth the effort and I should get on out and be comfortable, so I did.

We blew the hatch on the side after checking to see that everyone was clear outside, and came on out through the side hatch. I was

not in such bad shape at that time that I could not have gotten out through the top if I had had to do it. I still could have come out through the top.

But at that time I was hot. I'd been sweating for a long period of time and it seemed like the thing to do was to get on out of there at that time.

I think, perhaps, the difficulty that we had and the action I had to take may actually have been a blessing in disguise in one way, because it showed when we had to, that a man can take over control of the various systems and operate manually and still know what he's doing and not have any ill effects in this regard from zero-G.

And probably, if sufficient study of our records from this flight warrants it, we probably can go on some future flights with considerably less automation and less complexity, we hope, as a result of some of the things that we learned on this flight. We certainly hope so, anyway.

But before we make any big decisions along that line, of course, we want to review a lot of the data much more thoroughly than we have so far.

These things are all step-by-step items. Al, of course, added to our knowledge a large amount on his flight. Gus added a little more, I guess, on this one, and there'll be many more to come.

Deke (D. K.) Slayton, of course, is up next, and we're looking forward to that flight with just as eager anticipation for him as I looked forward to this one for me.

I think we've really hardly scratched the surface. We had a lot of attention focused on this one right now, but our efforts really haven't gotten us very far into space, if you think about it.

If you think of the diameter of the earth being represented as some 100 miles to the inch, this would mean that the earth's diameter could be represented by 80 inches approximately, which would only be about 10 inches higher than I am.

If I held my hands up over my head this would be of the order of 80 inches if I were standing up. Our orbital altitude, if that was the surface of the earth and I was the diameter line of the earth—our orbital altitude would be about one and a third inches above that 80 inches.

So perhaps if you think of the enormity of space it makes our efforts seem puny at this time. But these are all step-by-step functions we go through. As we said, all the manned flights we've had to date have added information. This flight, I hope, added a little bit more and there are more to come.

I might add one thing here. One person I wanted to pay a real tribute to, who has worked long and hard particularly close with me during this and that's Scott Carpenter. Where is Scott? He's around here someplace. Stand up.

Nobody knows the hours that he put in for somebody else. We saw Scott a couple of days ago perform another feat, too. He risked his own life to save another man's life while swimming out at Grand Turk the other day. That may not be generally known, either.

This was very impressive. When you have an aqualung and you're down at about 80-foot depth and you're trying to give your own air to somebody else to help them out, this is almost heroic, in my book.

One of the people here, I think you may have seen this morning in some of the activities, I'd like to introduce here. Here's the real brains and power behind our household, my wife, Annie, right here.

My daughter, Lynn, and son, Dave, right next to her, here.

My mother and dad who, as the President said this morning, started all this trouble a long time ago.

And Annie's father and mother, Dr. and Mrs. Castor.

I think gathered around here in front are the other astronauts and their wives. I think you know most of them by sight. I'm afraid it would take too much time to introduce everyone individually.

Why shouldn't we have everyone stand all at one time—all the rest of the families who are here? We have quite a contingent here, and the little ones, too.

We were interested, of course, in some of the reactions from abroad with regard to the flight.

I think it is well to note in this regard that as far back as 1958 the President at that time, President Eisenhower, of course, proposed that we make joint efforts with other people in regards to our exploration of space, and these were largely ignored at the time.

President Kennedy, shortly after his inauguration, or during his inauguration, in his address, I believe, reiterated this again, the desire for the peaceful exploration of space and peaceful cooperation in this regard.

So we don't want to let this particular initiative I don't think, be taken away from us. This has been proposed for quite some period of time by our own leaders in this country.

I think I couldn't pass up any opportunity like this without rendering a great note of thanks to all the people here at the Cape and the whole Mercury network who performed so beautifully during the flight.

They acted like a real bunch of pros and it was real gratifying, after all the practice we had been through with them, to see everyone come through as they did during the flight. This goes from the blockhouse through, I hate to start mentioning names, because we just wouldn't know where to cut it off, and I'd hate to hurt anybody's feelings by missing them, so I won't start.

But the blockhouse crew and the people at the hangar that checked out all the capsule and the boosters and the work on efforts of the Navy, the Air Force support we had, it was just a big across-the-board team effort.

It was, as I said earlier, I think almost a crosscut of Americana, of all people in different walks combining together on a project and we got the results we did.

It makes you proud to be associated with people like that when everyone does work together so cooperatively.

I think that President Kennedy, in repeating our desire for peaceful efforts in space, stated the case very aptly and properly. I don't know what I could add to what he has said on it. Diplomacy obviously is not my particular field.

If the results of this flight could possibly, I guess, have some far-reaching effect in this regard, if it contributes in any way to peace through our efforts, I certainly would consider that there is no better purpose in my life or my endeavor to contribute than what we might have a little more peaceful cooperation in the world in this area. Thank you.

Colonel POWERS. While John is getting started with the question period, I would like to ask, since we don't have mikes out in the audience, would you please stand, identify yourself, and let us hear your questions?

Question. I'd like to know at this time whether other trips are planned for you.

Answer. The answer to the first question, obviously, is "Yes." The answer to the second question "No". I have no knowledge of future flights. As I've said before, this stuff is—you can become addicted to it rather rapidly.

Question. Any man that flies as well as John Glenn will fly again.

Answer. I'm with you.

Question. Colonel Glenn, based on your experience and ability to fly the capsule when the control malfunction developed, what changes are you going to recommend in the capsule's control for Deek Slayton's flight?

Colonel POWERS. Did everybody hear the question? The question was: In view of the difficulties we had in our attitude control system, what changes was John going to recommend in Deek Slayton's spacecraft?

Colonel GLENN. Was that the question of changes in the system itself or changes as a result of his ability to control properly?

Question. Changes in the control system and also how much more do you think a man can do?

Answer. Well, before we make any positive statement like that as to the exact recommendations for future flights, we need to do a lot more looking into records and data and get all the tapes back from the various stations around the network and we have several weeks' work to do just sitting down and analyzing the data.

I don't think I want to get in at this time to any statements that I recommend this or that on the preliminary look that we've had at the information so far.

Question. Colonel Glenn, what did the stars and the earth look like up there?

Answer. Well, stars—I was a little bit surprised. I think I maybe expected to see the stars in greater quantity and greater numbers than I had seen them before. The nearest thing I could compare it to, and did compare it to during debriefing, was the—I think—if you've been out in the desert on a very clear brilliant night when there's no moon up and the stars just seem to jump out at you, that's just about the way the stars look.

We get some light reduction because of the light having to come through the window of the capsule, of course. And apparently this reduction in light may almost approximate the atmosphere.

So I didn't feel that I could see any greater number of stars. They were not blinking. They came through very clear with a straight shining light.

There was no flickering on and off. But other than that, it looked very similar to looking at the sky on a very, very clear night in the desert.

Question. John there were a number of experiments you were not able to make because, of course, you were busy flying the spacecraft. Could you give us a general idea of some of those that you were not able to perform this time, with a reflection here as to perhaps what we might expect from Deek Slayton's ride?

Answer. Well, there were several that we had wanted to look at. We wanted to take some infrared pictures for the weather people. We wanted to take some ultraviolet pictures around on the dark side.

We had some eye checks with some small instruments that we wanted to make. There were several things of this nature—I was going to eat some more. I never got around to that after our difficulties started a little bit.

Well, what else did we have? This yellow air glow filter that would only pass a yellow light which was of interest to some of the weather people. That's about it.

Question. When did you know that you had a possible emergency on your hands (the heat shield problem), and how concerned were you about it?

Answer. I don't recall the exact time that I knew about it. I knew about it for some time in advance of the retro sequence. I can't pin a time to it exactly. I didn't really contest this decision from the control center, because I knew that the experts we had on the ground had certainly thought this thing out much more thoroughly than I could in flight to make the recommendation that they could make. I knew that there would not be any change of this magnitude made unless it had certainly been considered from every possible angle by many, many experts on the ground, all the people that designed the system and all the other experts that were in the control center.

So, while it was of some concern, of course, because it was a malfunction; we never have had a capsule reenter with a retro pack on it before. Something untried like that you look at it with a—a little bit askance maybe before you try it, of course, so there was some concern about it.

I think the major concern when these chunks started breaking off during reentry and I could see them going back by the capsule. This was a period when I wasn't sure whether it was a retro pack or whether it was a damaged heat shield beginning to break up. Obviously it was the retro pack.

Question. Could you tell us of some of the things you saw on earth during the course of your flight while you were up there? Is there anything now that stands out in your mind as the most spectacular or most interesting thing that you saw on the surface of the earth?

Answer. The question was what were the most spectacular things I could see. Well, No. 1 it's all very spectacular from up there. You can see a tremendous distance. You're up above the atmosphere. You see this little horizon band of very brilliant blue color even on the day side.

It would be difficult to pin down any one thing as being more spectacular than others. Certainly one of the most beautiful things is to be on the dark side with the full moon out and see this coming off the clouds down below.

And then running over and seeing the very sharp demarcation line where the stars keep coming down below the horizon. It's interesting to note that your sunsets and the stars moving behind the horizon occur at approximately 18 times their normal speed. This makes for a pretty speedy sunset.

Colonel POWERS. John, you mentioned in the debriefing—made some observations about how you could see the earth's surface—being able to tell the difference between land and sea.

Colonel GLENN. Yes. You can see different patterns in the ocean currents, like the Gulf Stream, for instance. You can see the changing colors there. You can see on the earth—one area that I could observe very clearly was the area northwest of El Paso.

And that's an area where there's a lot of desert with a big irrigated area that comes down a valley northwest of El Paso, and that stood out very much. You can see the squares of the irrigated areas from this distance.

I wouldn't guarantee that I was seeing the smallest irrigated squares that they have—each individual patch, but the larger irrigated squares probably had major dikes around them. I could see these very clearly.

Patterns like that I think you may see 8 patterns around the cities, where you think, "well now there's a bridge"—you could see a little dot or a little spot and you think, "well there's a bridge."

I think you determine a lot of this by, possibly, the fact that you see a valley and a river and you know that at a town like that, if there's a spot there it's probably a bridge across that river. And then you say, "well that's a bridge."

You can't pick out things like a bridge or a railroad trestle or anything like that with any certainty from this type distance, of course.

Question. El Centro, Calif. and perhaps the larger nearby cities, like San Diego?

Answer. I didn't see San Diego. I saw part of the Imperial Valley. I could see the Salton Sea. This was an area that was a sort of a gap in the clouds at that time, once again you could see all the irrigated district around El Centro. And I had lived in El Centro a number of years ago for a short time so I was familiar with the area.

The Salton Sea area was very, very visible. Towns over, you can see blocks or squares in towns. We had figured before we probably would be able to pick out items down to, say, a hundred yards to 150 yards long and I think this was probably a fair estimate.

Question. I think it * * * said yesterday that after checking you out he wouldn't mind sending his wife and his 14-year-old son * * * he was sure that he would get the facts. Do you agree that future astronauts might need much more physical training than you and your colleagues—? (Part of this question, indicated by asterisks, was unintelligible.)

Answer. The question was the remark that Bill Douglas made about the condition I came back in, he'd have been willing to send his wife and son along. And did this mean that we probably could do with less physical conditioning in the future?

Well, I would have been very happy to have had Mary and Mike along, but it was a little bit crowded.

But as far as lessening our physical training I don't think so. You don't know what you might run into on future flights, and we certainly would not want to make a categorical statement that because we had this one successful outing, we would never run into any more strenuous things physically than we ran into this time.

I think in at least the foreseeable future we would want to be as prepared as we could for any contingency we would run into as we were this time.

Colonel POWERS. Yes, I think it is important to indicate that Dr. Douglas qualified his statement yesterday, referring specifically, for

example, to geologists, and he indicated that we would first select a group of geologists, and then take the most physically fit from among those. Mr. Bates back there has been waving frantically.

Question. In the future we have planned to experiment with a so-called rendezvous or docking technique in space, and it's going to be important to know how your depth perception is in space. Did you have any trouble figuring out just where the booster was when it started leaving the capsule?

Colonel GLENN. No. This was quite a sight. Right at turn around they separated from the boosters * * * turn around, and as it swung around the booster was sitting there, probably within a hundred yards. Very visible, very clear.

We talked about this during debriefing. If I had the capability of having a little thrust to move over that direction, could I have maneuvered toward it? I think very definitely you could. I don't think this would be any problem at all from that distance.

Now the booster because of its different velocity, assumes a little different orbit than I had, and it went slightly under me and was passing ahead of me and under in a lower orbit the last time I saw it. This was out pretty well toward the coast of Africa, and I didn't see it again after that.

Question. Did you have any trouble checking out the * * * fairly smoothly?

Answer. Well, I—You say with no reference point, we would have no trouble. I think you're always going to have a reference point of sorts. It may be stars or it may be an artificial horizon that you have set up at a certain gyro angle, but I don't think you're, in effect, you'd be saying you couldn't rendezvous as a blind person, and this is true. I think you'll always have some reference, though. I don't think you'd be completely without reference.

Question. We know the answers aren't all in yet, but on the basis of your present judgments, where would you pin down the control problems—to the horizon scanners that reset the gyros, to the gyros or to that reaction jet that didn't appear to be working?

Answer. I think it was a combination of things. I think we had a little bit of structure trouble. I think we, on the horizon scanners, I'm not sure. I think that perhaps some of the horizon scanner trouble could have been eliminated had we gone to a pregyro position. We didn't do this.

We're still getting our horizon scannery inputs. This may possibly have added to our troubles. It's easy, though, to hindsight this 20-20 after you're on the ground, but we're still looking into these things.

Question. Could you tell me what the highest cabin temperature during the flight?

Answer. I think the onboard cabin temperature, about the highest I observed, was about 105 (degrees). This once again, we're checking telemetry records and will probably have more accurate information on that later on.

Question. I assume you had ophthalmological examination. I wondered if the physicians found any cosmic ray tracks in the lenses of your eyes, and if so, how dense are they?

Answer. The question is whether I have had a complete eye examination following this flight, whether there has been any cosmic ray indication of damage to the eyes. Where's Bill Douglas, I think he should answer all this on the medical information.

Dr. DOUGLAS. No damage.

Question. I didn't ask whether there was damage. I asked if there were any tracks. Dr. Douglas, any tracks?

Dr. DOUGLAS. No tracks. No tracks in the eyes.

Question. I'd like to ask two questions, Colonel Glenn. First of all, elaborate preparations were made prior to the flight and during the flight to ascertain certain facts with regard to international records—First, of all, what records were we after and what will be claimed in the way of records? And the other is, what pictures did you manage to take, have they been developed, and what do they show, if anything, and will we get them?

Answer. Private press conference?

Question. I'll see you later?

Answer. Let me talk about the records first, the international flight records. The international flight records, I didn't go into this in any great detail as to all the flight records that might be claimed as the result of something like this.

We understood that there had been some question of verification from the earlier orbital flights and I have no comment on that one way or the other.

They wanted to adequately verify these flights. I was busy enough with preparations. I didn't worry too much about certification, I'm afraid.

I might say that the F.A.I. did witness the flight, they had witnesses on both ends, they have acquired the proper certificates and we will turn our data over to them. Ah, about the pictures, John.

Pictures were taken of general views of different land areas, areas that were particularly clear—Florida here, the lower eastern, southern part of the United States, taken from an angle; Africa, the desert area, many cloud pictures, many sunrise pictures.

I tried to get pictures of the little glowing objects I described. Apparently they were not of sufficient intensity to come through, at least on the first look that we took from reproductions of the pictures the other day. And as to when these will be released, I have no ideas. We're still looking at them.

Question. Did you notice any difference in the accelerative effects on the body as opposed to the decelerative effects on the body at the end of the flight as a result of this period of weightlessness?

Answer.—I noticed no effects at all. It felt just the same on reentry as our runs on the centrifuge, where we were practicing reentry, for instance. It got up to about 8 g.'s, and this is a very powerful level with the body in the couch the way we are, and I had no ill effects from it at all.

At 8 g.'s you're not just lying back relaxed. You're working against it, but we have all been up to the neighborhood of 14 to 16 g.'s previously.

Question. Colonel Glenn, two questions: One, can you be just a little bit more specific on when you got the indication of trouble with the heat shield? We were told that it was in the first orbit. I'd like to know if it was in the first or the second orbit.

Secondly, apparently there was some discussion about aborting the mission after the second orbit or ending the mission prematurely. I was wondering if you can tell us about this and whether it was on your decision that they went on into a third orbit.

Answer. Well, let's see. The first question was whether I can be more specific on when I had information that we might have heat shield trouble. I really don't recall. Do you recall, Al, you were on?

Comdr. ALAN B. SHEPARD, Jr. On the third orbit over Hawaii.

Colonel GLENN. That was just before retro.

Commander SHEPARD. Yeah.

Colonel GLENN. That's on the third orbit.

Colonel POWERS. The people in the Control Center knew about it much earlier in the flight. I think perhaps the first you knew about it, John, was down the third orbit.

Colonel GLENN. Well, you knew it, I believe, at the end of the first orbit. I think they knew it at the end of the first orbit. Don't pin me down on this one, but I believe they knew it at the end of the first orbit, and I think there were questions put out to me about it during that second orbit—about whether I had a light indication or not.

Once again, we'll play back the tapes and we can have it down almost to the second. I don't believe this is of any significance however.

The second part of your question—whether to terminate the flight at the end of two orbits. There was a decision to be made there, because we had had some control system problems.

At that time I think the control center felt that we had the capsule under fine enough control that we would gain nothing by reentering at that time. I felt the same way. My recommendation was that we were still in a go status. They agreed. We were still go, so we went to three orbits.

If anything, at a time like that, if you are going to have to make a manual retro fire you might well stay up a while and get more practice.

John, you said, "Boy that was a real fireball" as you started entry process. Can you describe to us your sensation as you started and during reentry and the kind of controlling you were doing reentry until the chute opened.

Answer. The sensation during reentry during the fireball. I guess you'd say cautious apprehension, or something like that. Now there is an unknown area, of course. We've had very little experience with a man inside a glowing fire like this that you can see outside the window. We have confidence that the ablation shield will take care of this. It did.

But this is a completely new experience and you're a little apprehensive of it at the time, I think.

Question. Tell about the kind of control that you were doing.

Answer. Kind of control was damping. It was not controlling for specific attitude. As the capsule would set up oscillations you'd just try and damp them out and keep the thing to as near a zero rate as you can.

The only movement the capsule was making—you do have a constant roll rate at that time of about 10 degrees per second, which gives us our even flight path as she comes down, so that you don't get any dispersion from O being a little off location.

Question. Colonel, how large a view did you have at any one time. For example, could you see all of Florida and more at one glance?

Answer. Yes. You can—well, when I was well up the east coast here once I could see back across Florida, and I remember stating that I could see the Mississippi Delta at that time. It was pretty clear along the gulf coast.

at Your view to the horizon is about—approaches 900 miles.

Question. Colonel Glenn, when you go automatic on your control system * * * if you used your hydrogen peroxide at a greater rate, and therefore when you switch * * * you're actually saving your hydrogen peroxide, does this hamper you * * * your other duties or * * * fly-by-wire and still perform all that is meant to be done?

Answer. The question is whether when we go on manual control and switch back and forth from automatic to manual, whether we waste fuel doing this, since the capsule drops into this high torque orientation mode, was that what you were referring to?

The answer is, you don't drop into this high torque mode if you position the capsule accurately on your orbit attitude that you want to begin with before you switch over. If you switch over to automatic mode when you're way out at some odd-ball attitude, then it kicks into this high torque mode, uses fuel at a rather rapid rate so you don't want to do that too many times. If when you're on manual though you position the capsule before you switch back to automatic you use no more fuel than you would normally.

Question. Colonel Glenn, did you observe anything that was at variance with the reports of the two Russian astronauts?

Answer. Well, I don't know that we've had real complete reports from the Russian cosmonauts on what they observed or saw or felt. We've had some reports.

I don't believe I'd care to comment on it any further than that. I think probably this will be the subject of more discussion as we learn more about their program. Perhaps we should ask them. Our program is completely open. Theirs is the secret one. They can compare with what I saw.

Question. Do you have any point of reference to measure or estimate the size of these particles, or conceivably could they have been much larger and farther away?

Answer. No, I don't think so, because, I could see some drifting up very close to the window and come in the shadow of the capsule, and they'd lose most of their phosphorescence or luminescence as they came into the shadow area right close to the capsule. You could see them just outside the window, you could see the little diameters.

Also you could look off to the side, and as you moved through this field of particles, or whatever it was, you could see them changing relative positions to the capsule as you went by, and this gives you sort of a depth perception.

Question. Colonel, could you elaborate on the report that you saw some orange and blue bands at sunset or as you were going into the sunset?

Answer. Yes, you do. You see, the question is whether I had orange and blue bands visible at sunset. Whenever these pictures are released I think they'll show some of this.

As the sun goes down it's very white, brilliant light, and as it goes below the horizon and you get your light coming to you then through the atmosphere, it's a very bright orange color; down close to the surface, it pales out into sort of a blue, a darker blue, and then off into black.

It's like looking at a spectograph pretty much, if you've ever done that. It just broadens out your whole—takes your white light and broadens it out into all its color elements and that's just about

what you see. It's not quite like a rainbow but it's the same principle involved anyway.

Question. Mr. — (Question completely unintelligible).

Answer. How long did I control on fly-by-wire and how long on manual? This is something we want to total out. It was for very extended periods of time.

The last, practically all of the last two orbits I was on either fly-by-wire or manual, so there'll be probably, maybe an hour and 15 minutes average for each control mode.

But that's not a real definitive statement. We have to total these times up when we can get the records analyzed.

Question. What was the noise level inside the capsule in orbit?

Answer. The noise level in the capsule was very similar to what it is on the pad out here. You have the whine of the inverters, the byros, the valves, the hiss of the oxygen in the helmet. It's not a loud intensity. I don't know what the decibel level of it is exactly, but it didn't appear to be any different in orbit than it is out here when we're running checks on the pad.

Question. John, can you give us some idea of your schedule for the next few days and particularly, when do you have to get back to work?

Answer. Wow. The question is about my schedule for the next few days and when I'm going to get back to work. I don't know. I think our schedule for the next few days is a little bit vague at the moment. I don't know what we're putting out on that.

Mr. WENN. The Speaker of the House has invited Colonel Glenn and all of the astronauts and their wives to a joint session of the Congress on Monday. It is not yet determined as to whether all wish to go or can go, but certainly Colonel Glenn will be there, I think, because he has been invited to address the joint session.

Now beyond that, it is planned to have a press conference in Washington for the Washington press following a luncheon which the Vice President and I will give on Monday.

Beyond that is the plan that the four astronauts who have not yet flown will continue with their programs and the mayor of New York has invited Colonel Glenn and Commander Sheppard, Captain Grissom and Bob Gilruth up to receive the welcome of the city, and to have a parade and to be received in City Hall by His Honor, the Mayor.

All of this is sort of in a tentative or somewhat definite planning stage. We're going to have a conference right after this meeting with all the astronauts to see what their desires are.

Dr. Dryden, Dr. Siemens and I are going to meet with Bob Gilruth here and then fly back together tonight to try to figure out precisely what the situation is. I may say that the mayor of St. Louis has asked urgently that I bring Alan Shepard with me there tomorrow, where I am going to make the Founder's Day address at Washington University again. This is a subject we'll discuss after this meeting.

Colonel POWERS. Last question.

REPORTERS. No, No.

Question. Colonel Glenn, did you hear Commander Shepard advise you to try to jettison your retro-pack when you reached 1 to 1½ G's on the reentry?

Answer. No. I did not. And this occurred just as the beginning of communications loss, and the reason we know this is last night,

after we finished a meeting, we finally had copies of the on-board recorder tape and we played these over last night rather late and went through the reentry.

And Al comes on the air just as the start of this communication and starts to tell me to jettison this and the people that were listening with me said that this is what he went ahead and said.

He's about half-way through his transmission and fades right out to nothing, and I never received it. If we had had 3 more seconds, I guess, of time before we got our communications blackout during reentry, I would have received the message.

Yes. The straps were gone by then anyway. The straps went off when we had, I estimate, not over half a G on the capsule. It was early in the program.

Colonel POWERS. OK, we'll stop on the hour.

Question. Colonel Glenn, your wife showed us this morning the pin that you gave her of the Mercury Orbital Friendship 7. I was wondering if you had any other personal effects with you in the capsule?

Answer. None to speak of.

Question. Did you use the little red lights at the end of your fingertips on your gloves?

Answer. Yes. I found these very handy. These were—I could turn them on and off with a little switch on the back of the hand. The little fingertip lights are very small bulbs, for looking at charts, for checking the maps and in the tight capsule lighting we have, these turned out to be very handy and I used them repeatedly. I like them very much and glad we decided to put them on.

Question. I would like to know if it has been determined as yet whether you'll have to wait for a future date as to whether the heat shield was actually in danger of becoming loose or whether it was actually a false signal?

Answer. No, it was a false signal. I think this has been reasonably well determined now that it was a faulty signal.

Mr. WEBB. I guess it was the day before yesterday, Walt, before you came over to GBI, that it was a malfunctioning limit switch that gave a false signal. The heat shield was securely lodged all the time we were worrying so.

Answer. I don't recall the exact time that I knew about it. I knew about it for some time in advance of the retro sequence. I can't pin a time to it exactly. I didn't really contest this decision from the Control Center, because I knew that the experts we had on the ground had certainly thought this thing out much more thoroughly than I could in flight to make the recommendation that they could make.

I knew that there would not be any change of this magnitude made unless it had certainly been considered from every possible angle by many, many experts on the ground, all the people that designed the system and all the other experts that were in the Control Center.

Question. Colonel, if we could get back to your schedule rather briefly once again, and perhaps Mr. Webb could tell us. Do you have any plans to go outside of the United States and would you object to being utilized in the way that Major Gagarin was?

Answer. Well, I think that this gets into a little different field than I'm qualified to comment on right now. We may have to discuss

some things like this in the future. I think there are no plans immediately that I know of.

Mr. WEBB. May I say just this word there. Obviously this program has many implications for the total foreign policy image of the United States abroad. We of course want to learn all we can about space. We want to learn to use men in space, but we must be conscious of these other implications.

These questions will be debated with great care. Colonel Glenn and the other astronauts will be consulted with respect to the work-out of the plan, and I think that you can expect, though, more activity than in the past.

As a matter of fact, I told Alan Shepard and Gus Grissom this morning that after the New York parade, if they wanted to have sometime out of jail, they'd be not under the same restrictions they have been in the past.

I believe I forgot to mention the fact that Colonel Glenn's hometown is very anxious to have him on Friday after the New York parade. But I think all of this will come out pretty soon after the decisions have been made.

Obviously, he is going to decide himself what he wants to do.

Colonel POWERS. We are out of time. Thank you very much.

Answer. I found these very handy. There were—I could turn them on and off with a little switch on the back of the hand. The little fingertip lights are very small bulbs for looking at charts. For checking the maps and in the light capsule lighting we have, I think turned out to be very handy and I used them repeatedly. I like them very much and glad we decided to put them on. Question. I would like to know if it has been determined as yet whether you'll have to wait for a future date as to whether the heat shield was actually in danger of becoming loose or whether it was actually a false signal?

Answer. No, it was a false signal. I think this has been reasonably well determined now that it was a faulty signal. Mr. WEBB. I guess it was the day before yesterday. Wait, before you came over to GBI, that it was a malfunctioning heat switch that gave a false signal. The heat shield was securely lodged all the time we were worrying so.

Answer. I don't recall the exact time that I knew about it. I knew about it for some time in advance of the return sequence. I can't pin a time to it exactly. I didn't really contest this decision from the Control Center, because I knew that the experts we had on the ground had certainly thought this thing out much more thoroughly than I could in flight to make the recommendation that they could make.

I knew that there would not be any change of this magnitude unless it had certainly been considered from every possible angle by many, many experts on the ground, all the people that designed the system and all the other experts that were in the Control Center.

Question. Colonel, if we could get back to your schedule rather briefly once again, and perhaps Mr. Webb could tell us. Do you have any plans to go outside of the United States and would you object to being utilized in the way that Major Gagarin was?

Answer. Well, I think that this gets into a little different field than I'm qualified to comment on right now. We may have to discuss

APPENDIX H

COLONEL GLENN'S MESSAGE TO THE JOINT MEETING OF CONGRESS, FEBRUARY 26, 1962

The Speaker of the House presided.

At 12 o'clock and 53 minutes p.m., the Doorkeeper announced the President pro tempore and Members of the U.S. Senate who entered the Hall of the House of Representatives, the President pro tempore taking the chair at the right of the Speaker, and the Members of the Senate the seats reserved for them.

The SPEAKER. On the part of the House the Chair appoints as members of the committee to escort Lieutenant Colonel Glenn into the Chamber, the gentleman from Oklahoma [Mr. Albert], the gentleman from Louisiana [Mr. Boggs], the gentleman from Georgia [Mr. Vinson], the gentleman from California [Mr. George P. Miller], the gentleman from Indiana [Mr. Halleck], the gentleman from Illinois [Mr. Arends], and the gentleman from Massachusetts [Mr. Martin].

The PRESIDENT pro tempore. On the part of the Senate the Chair appoints as members of the committee of escort the Senator from Montana [Mr. Mansfield], the Senator from Georgia [Mr. Russell], the Senator from Oklahoma [Mr. Kerr], the Senator from Arkansas [Mr. Fulbright], the Senator from Illinois [Mr. Dirksen], the Senator from Massachusetts [Mr. Saltonstall], the Senator from Wisconsin [Mr. Wiley], and the Senator from California [Mr. Kuchel].

The Doorkeeper announced the ambassadors, ministers, and *chargés d'affaires* of foreign governments.

The ambassadors, ministers, and *chargés d'affaires* of foreign governments entered the Hall of the House of Representatives and took the seats reserved for them.

The Doorkeeper announced the Chief Justice of the United States and the Associate Justices of the Supreme Court.

The Chief Justice of the United States and the Associate Justices of the Supreme Court entered the Hall of the House of Representatives and took the seats reserved for them in front of the Speaker's rostrum.

At 1 o'clock and 6 minutes p.m., Lieutenant Colonel Glenn's fellow astronauts, Virgil I. Grissom, Alan B. Shepard, Jr., Donald K. Slayton, Malcolm S. Carpenter, and Walter M. Schirra, entered the Chamber. [Applause, the Members rising.] (The other astronaut, Leroy G. Cooper, Jr., was in Australia.)

The Doorkeeper announced the Cabinet of the President of the United States.

The members of the Cabinet of the President of the United States entered the Hall of the House of Representatives and took the seats reserved for them in front of the Speaker's rostrum.

At 1 o'clock and 8 minutes p.m., the Vice President entered the Chamber and assumed the chair vacated by the President pro tempore at the right of the Speaker.

At 1 o'clock and 13 minutes p.m., the Doorkeeper announced Lieutenant Colonel Glenn.

Lieutenant Colonel Glenn, accompanied by the committee of escort, entered the Chamber and stood at the Clerk's desk. [Applause, the Members rising.]

The SPEAKER. Members of the Congress, it is a privilege, and I deem it a high honor to present to you a brave, a courageous American, a hero in World War II and in the Korean conflict, who recently in a most notable manner added glory and prestige to our country, the first U.S. astronaut to have achieved orbital flight, Lt. Col. John H. Glenn, Jr., U.S. Marine Corps. [Applause, the Members rising.]

Lieutenant Colonel GLENN. Mr. Speaker, Mr. President, Members of the Congress, I am only too aware of the tremendous honor that is being shown us at this joint meeting of the Congress today. When I think of past meetings that involved heads of state and equally notable persons, I can only say I am most humble to know that you consider our efforts to be in the same class. [Applause.]

This has been a great experience for all of us present and for all Americans, of course, and I am certainly glad to see that pride in our country and its accomplishments is not a thing of the past. [Applause.]

I still get a hard-to-define feeling inside when the flag goes by—and I know that all of you do, too. Today as we rode up Pennsylvania Avenue from the White House and saw the tremendous outpouring of feeling on the part of so many thousands of our people I got this same feeling all over again. Let us hope that none of us ever loses it. [Applause.]

The flight of *Friendship 7* on February 20 involved much more than one man in the spacecraft in orbit. [Applause.] I would like to have my parents stand up, please. [Mr. and Mrs. John Glenn, Sr., stood and received the rising applause of the Members.]

My wife's mother and Dr. Castor. [Dr. and Mrs. H. W. Castor stood and received the rising applause of the Members.]

My son and daughter, David and Carolyn. [David and Carolyn Glenn rose and received the rising applause of the Members.]

And the real rock in my family, my wife Annie. [Mrs. John H. Glenn, Jr., rose and received the applause of the Members.]

There are many more people, of course, involved in our flight in *Friendship 7*; many more things involved, as well as people. There was the vision of Congress that established this national program of space exploration. Beyond that, many thousands of people were involved, civilian contractors and many subcontractors in many different fields; many elements—civilians, civil service, and military, all blending their efforts toward a common goal.

To even attempt to give proper credit to all the individuals on this team effort would be impossible. But let me say that I have never seen a more sincere, dedicated, and hard-working group of people in my life. [Applause.]

From the original vision of the Congress to consummation of this orbital flight has been just over 3 years. This, in itself, states eloquently the case for the hard work and devotion of the entire Mercury team. This has not been just another job. It has been a dedicated labor such as I have not seen before. It has involved a crosscut of American endeavor with many different disciplines cooperating toward a common objective.

Friendship 7 is just a beginning, a successful experiment. It is another plateau in our step-by-step program of increasingly ambitious flights. The earlier flights of Alan Shepard and Gus Grissom were

steppingstones toward *Friendship 7*. My flight in the *Friendship 7* spacecraft will, in turn, provide additional information for use in striving toward future flights that some of the other gentlemen you see here will take part in. [Applause.]

Scott Carpenter here, who was my backup on this flight; Walt Schirra, Deek Slayton, and one missing member, who is still on his way back from Australia, where he was on the tracking station, Gordon Cooper. A lot of direction is necessary for a project such as this, and the Director of Project Mercury since its inception has been Dr. Robert Gilruth, who certainly deserves a hand here. [Applause.]

I have been trying to introduce Walt Williams. I do not see him here. There he is up in the corner. [Applause.]

And the Associate Director of Mercury, who was in the unenviable position of being Operational Director. He is a character, no matter how you look at him. He says hold the count-foul, and one thing and another.

With all the experience we have had so far, where does this leave us?

There are the building blocks upon which we shall build much more ambitious and more productive portions of the program.

As was to be expected, not everything worked perfectly on my flight. We may well need to make changes—and these will be tried out on subsequent 3-orbit flights, later this year, to be followed by 18-orbit, 24-hour missions.

Beyond that, we look forward to Project Gemini—a two-man orbital vehicle with greatly increased capability for advanced experiments. There will be additional rendezvous experiments in space, technical and scientific observations—then, Apollo orbital, circumlunar and finally, lunar landing flights.

What did we learn from the *Friendship 7* flight that will help us attain these objectives?

Some specific items have already been covered briefly in the news reports. And I think it is of more than passing interest to all of us that information attained from these flights is readily available to all nations of the world. [Applause.]

The launch itself was conducted openly and with the news media representatives from around the world in attendance. [Applause.] Complete information is released as it is evaluated and validated. This is certainly in sharp contrast with similar programs conducted elsewhere in the world and elevates the peaceful intent of our program. [Applause.]

Data from the *Friendship 7* flight is still being analyzed. Certainly, much more information will be added to our storehouse of knowledge.

But these things we know. The Mercury spacecraft and systems design concepts are sound and have now been verified during manned flight. We also proved that man can operate intelligently in space and can adapt rapidly to this new environment.

Zero G or weightlessness—at least for this period of time—appears to be no problem. As a matter of fact, lack of gravity is a rather fascinating thing.

Objects within the cockpit can be parked in midair. For example, at one time during the flight, I was using a hand-held camera. Another system needed attention; so it seemed quite natural to let go of the camera, take care of the other chore in the spacecraft, then reach out, grasp the camera and go back about my business.

It is a real fascinating feeling, needless to say.

There seemed to be little sensation of speed although the craft was traveling at about 5 miles per second—a speed that I, too, find difficult to comprehend.

In addition to closely monitoring onboard systems, we were able to make numerous outside observations.

The view from that altitude defies description.

The horizon colors are brilliant and sunsets are spectacular. It is hard to beat a day in which you are permitted the luxury of seeing four sunsets.

I think after all of our talk of space, this morning coming up from Florida on the plane with President Kennedy, we had the opportunity to meet Mrs. Kennedy and Caroline before we took off. I think Caroline really cut us down to size and put us back in the proper position. She looked up, upon being introduced, and said, "Where is the monkey?" [Laughter.]

And I did not get a banana pellet on the whole ride.

Our efforts today and what we have done so far are but small building blocks in a huge pyramid to come.

But questions are sometimes raised regarding the immediate payoffs from our efforts. What benefits are we gaining from the money spent? The real benefits we probably cannot even detail. They are probably not even known to man today. But exploration and the pursuit of knowledge have always paid dividends in the long run—usually far greater than anything expected at the outset. [Applause.]

Experimenters with common, green mold, little dreamed what effect their discovery of penicillin would have.

The story has been told of Disraeli, Prime Minister of England at the time, visiting the laboratory of Faraday, one of the early experimenters with basic electrical principles. After viewing various demonstrations of electrical phenomena, Disraeli asked, "But of what possible use is it?" Faraday replied, "Mister Prime Minister, what good is a baby?"

That is the stage of development in our program today—in its infancy. And it indicates a much broader potential impact, of course, than even the discovery of electricity did. We are just probing the surface of the greatest advancements in man's knowledge of his surroundings that has ever been made, I feel. There are benefits to science across the board. Any major effort such as this results in research by so many different specialties that it is hard to even envision the benefits that will accrue in many fields.

Knowledge begets knowledge. The more I see, the more impressed I am—not with how much we know—but with how tremendous the areas are that are as yet unexplored.

Exploration, knowledge, and achievement are good only insofar as we apply them to our future actions. Progress never stops. We are now on the verge of a new era, I feel.

Today, I know that I seem to be standing alone on this great platform—just as I seemed to be alone in the cockpit of the *Friendship 7* spacecraft. But I am not. There were with me then—and with me now—thousands of Americans and many hundreds of citizens of many countries around the world who contributed to this truly international undertaking voluntarily and in a spirit of cooperation and understanding.

On behalf of all of those people, I would like to express my and their heartfelt thanks for the honors you have bestowed upon us here today.

We are all proud to have been privileged to be part of this effort, to represent our country as we have. As our knowledge of the universe in which we live increases, may God grant us the wisdom and guidance to use it wisely.

Thank you, gentlemen. [Applause, the Members rising.]

At 1 o'clock and 32 minutes p.m., Lieutenant Colonel Glenn, accompanied by the committee of escort, retired from the Hall of the House of Representatives.

The Doorkeeper escorted the invited guests from the Chamber in the following order:

The members of the President's Cabinet.

The Chief Justice of the United States and the Associate Justices of the Supreme Court.

The ambassadors, ministers, and chargés d'affaires of foreign governments.

And during the recovery phase, spacecraft impact location predictions will have to be continuously revised and relayed to recovery forces. An industrial team headed by Western Electric Co. recently turned over this \$60 million global network to the National Aeronautics and Space Administration.

Other team members are Bell Telephone Laboratories, Inc.; the Bendix Corp.; Burris & Roe, Inc.; and International Business Machines Corp. At the same time, the Lincoln Laboratory of Massachusetts Institute of Technology also has advised and assisted NASA on special technical problems relating to the network.

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Sites linked across the Atlantic are Cape Canaveral, Grand Bahama Island, Grand Turk Island, Bermuda, Grand Canary Island, and a specially fitted ship in mid-Atlantic.

Other stations in the continental United States are at Point Arguello in southern California; White Sands, N. Mex.; Corpus Christi, Tex.; and Eglin, Fla. One station is located on Kauai Island in Hawaii.

There are two radar picket ships. The Atlantic ship *Rear Rod* will be stationed on the equator near the west African coast. The

we're delighted all of these people would like to express myland
their heartfelt thanks for the home ventura bedwax upon us

[illegible]

The following other sources have been used:

The members of the President's Cabinet and the Chief Justice of the United States and the Associate Justices

[illegible]

APPENDIX I

SUMMARY OF PROJECT MERCURY

(Mercury-Atlas 6 preflight information released January 21, 1962)

Mission.—Manned orbital flight to (1) evaluate the performance of a man-spacecraft system; (2) investigate man's capabilities in the space environment; (3) obtain the pilot's opinions on the operational suitability of the spacecraft and supporting systems for manned space flight.

Launch date.—The flight currently is scheduled no earlier than January 24, 1962. On whatever day, the launch will be attempted between 7:30 a.m. and 12:30 p.m. and may "slip" on a day-to-day basis as required. Launch timing will be planned to provide at least 3 hours of daylight search time in the probable recovery areas.

Flight duration.—Depending on literally thousands of variables, the Mercury Operations Director (Manned Spacecraft Center Associate Director Walter C. Williams) may elect a one-, two-, or three-orbit mission. That decision will be made only minutes before launch and may be changed at any time during the mission. Recovery after one full orbit is planned for about 500 miles east of Bermuda; after two orbits, some 500 miles south of Bermuda; three orbits, about 800 miles southeast of Cape Canaveral, Fla. Each orbit takes about 90 minutes, carrying the craft between 100 and 150 miles' altitude, 32° north and south of the equator.

If the mission ends after orbit 1 or 2, the astronaut will be moved to the Kindley Air Force Base Hospital in Bermuda for a 48-hour rest and debriefing. If the mission goes a full three orbits, he will be flown to Grand Turk Island (Bahamas) for a similar operation before being returned to the mainland.

Pilot.—Astronaut John H. Glenn, Jr., 40. A lieutenant colonel in the U.S. Marine Corps, Glenn has been with NASA for 3 years on a detached duty basis. Backup pilot for this flight is Astronaut M. Scott Carpenter, 36.

Spacecraft.—Bell shaped, the MA-6 craft—listed as No. 13 in engineering documents and named "Friendship 7" by Astronaut Glenn—stands 9½ feet high and measures 6 feet across the base. Spacecraft weight at launch will be about 4,200 pounds; spacecraft weight in orbit (after jettisoning of escape tower), 3,000 pounds; on-the-water recovery weight, 2,400 pounds. Prime contractor for the spacecraft is McDonnell Aircraft Corp. of St. Louis, Mo.

Launch vehicle.—A modified Atlas D is used to launch orbital Mercury missions, reaching a speed of 17,500 miles per hour. At launch, booster and spacecraft stand 93 feet tall, including a 16-foot tower above the spacecraft. The tower contains a solid propellant rocket hooked to an abort sensing system. Should trouble develop on the launch pad or in the early boost phase of the mission, the escape system will be triggered, automatically or by the pilot or from the ground, to pull the spacecraft away from the booster. The booster is manufactured by the Astronautics Division of General Dynamics Corp.

Network.—The Mercury tracking network consists of 18 stations around the world, including two ships, one on the Equator in the Atlantic off the coast of Africa and the other in the Indian Ocean. Some 500 technicians man these stations, all of which are in radio or cable communication with the Mercury Control Center at the Cape via the NASA Goddard Spaceflight Center at Greenbelt, Md. (See p. 46.)

Recovery.—More than 20 ships will be deployed in the Atlantic alone to take care of prime and contingency recovery areas. Recovery forces are under the command of Rear Adm. John L. Chew, commander of Destroyer Flotilla 4. In addition, ships and rescue planes around the world will go into action in the event of an emergency landing. More than 15,000 men will have a hand in the recovery, search, and rescue effort.

Responsibilities.—Project Mercury, the Nation's first manned space flight research project, was conceived and is directed by the National Aeronautics and Space Administration, a civilian agency of the Government charged with the exploration of space for peaceful and scientific purposes. Technical project direction for Mercury is supplied by NASA's Manned Spacecraft Center, directed by Robert R. Gilruth at Langley Field, Va., and soon to move to Houston, Tex. The Department of Defense, largely through the Air Force and Navy, provides vital support for Mercury. DOD support is directed by Maj. Gen. Leighton I. Davis, USAF, commander of the Atlantic Missile Range. In all, more than 30,000 persons will have a part in this mission, including Government and industry.

Project cost.—Total Project Mercury cost through orbital flight is estimated at \$400 million. About \$160 million will have gone to the prime spacecraft contractor, McDonnell, and its subcontractors and suppliers; \$95 million for the network operations; \$85 million for boosters, including Atlases, Redstones, and Little Joes; \$25 million for recovery operations and roughly \$35 million for supporting research in diverse areas.

Mission pilot tasks.—The MA-6 pilot will perform many control tasks during flight to obtain maximum data on spacecraft performance, his own reactions to weightlessness and stress, and to study the characteristics of the earth and stars from his vantage point over 100 miles above the earth's surface.

The astronaut will participate actively during the flight. This will include the following tasks:

(1) Manage the operation of all spacecraft systems, particularly the attitude control system, electrical system, environmental control system, and communications systems.

(2) Observe and correct any discrepancies in system operation. Discrepancies will be correlated with telemetered observations received at ground stations.

(3) Monitor critical events during launch, and terminate the mission if necessary.

(4) Maintain a complete navigation log during flight which will enable him to compute his retrofire time if ground communications should fail. This onboard navigation will include periscope ground sightings which indicate position over ground and altitude.

(5) Ground communications to receive updated retrofire information, and receive detailed behavior of spacecraft systems as determined from ground telemetry.

(6) Evaluate his physical condition to augment the biomedical data which are telemetered to the ground.

About every 30 minutes, the pilot will make detailed voice reports on spacecraft systems and operations conditions. His own transmissions will include critical information as mode of control, precise attitude, planned retrofire time, control system fuel, oxygen, and coolant.

MISSION PROFILE

Powered flight.—The manned Mercury spacecraft will be launched atop an Atlas from Cape Canaveral following a 2-day split countdown. Technical conditions or weather could, of course, delay the launch from minutes to days.

According to the flight plan, the spacecraft will be launched on a path along the Project Mercury worldwide tracking range on a launch heading of about 72°—just north of east from Cape Canaveral.

An internal programmer in the Atlas will guide the vehicle from lift-off until staging occurs. All of the Atlas liquid propellant engines are ignited before lift-off.

At staging, about 2 minutes after lift-off, the two booster engines will drop off and the sustainer and vernier engines will continue to accelerate the vehicle. Staging occurs at an altitude of about 40 miles and a range of about 45 miles from the launch pad.

During the first 2½ minutes of flight, an electronic brain, called the abort sensing and implementation system (ASIS) is capable of sensing impending trouble in the rocket and triggering the escape rocket. The astronaut can also trigger the Mercury escape rocket to pull the spacecraft away from the Atlas.

About 20 seconds after staging, and assuming the flight is proceeding as planned, the 16-foot escape tower and rocket will be jettisoned. Landing systems will be armed. The Mercury-Atlas vehicle will continue to accelerate toward the orbit insertion point guided by ground command guidance.

Until orbital insertion, the abort sensing system will continue to watch for trouble. If significant deviation should occur, the system will actuate circuits to release the spacecraft-to-Atlas clamp ring and fire the posigrade rockets on the base of the spacecraft.

About 5 minutes after lift-off, guidance ground command will shut down the sustainer and vernier engines. As the engines shut down, the spacecraft-to-boosters clamp ring is released automatically and posigrade rockets are fired to separate the craft from the Atlas.

Orbital insertion.—After a few seconds of automatic damping—getting rid of any unusual motions—the spacecraft will swing 180° so that the blunt face of the craft is turned forward and upward 34° above the horizontal. From that point on during orbital flight, the spacecraft can be controlled in proper attitude automatically or manually by the pilot.

If all goes well, the Mercury spacecraft will be inserted into orbit in the vicinity of Bermuda. By that time the vehicle will be at an altitude of approximately 100 miles and traveling at a speed of about 17,500 miles per hour. At engine cutoff, the craft will have been subjected to more than 7½ g. Reentry g. will also reach 7½.

A three-orbit flight will last approximately 4½ hours; a two-orbit flight, 3½ hours; one orbit, 1½ hours. The Mercury craft will reach

a peak altitude (apogee) of about 150 statute miles off the west coast of Australia and a low point (perigee) of 100 miles, at the insertion point near Bermuda.

Reentry.—After the desired number of orbits, as the spacecraft approaches the west coast of North America, retro or braking rockets will be fired to initiate reentry.

Shortly after the retrorockets are fired, the exhausted rocket package will be jettisoned and the spacecraft automatically will assume reentry attitude. Friendship 7 will begin to encounter more dense atmosphere of the earth approximately over the east coast at an altitude of about 55 miles. At this point, temperatures will start mounting on the spacecraft's ablation heat shield.

On a nominal mission, peak reentry temperature of about 3,000° F. will occur at 25 miles altitude while the spacecraft is moving at nearly 15,000 miles per hour. All told, the craft will sustain temperatures in this neighborhood for about 2 minutes.

Almost coincident with the heat pulse is a dramatic reduction in capsule speed. Between 55 miles and 12 miles altitude—covering a distance of 760 miles—spacecraft velocity should go from 17,500 miles per hour down to 270 miles per hour in a little over 5 minutes.

At about 21,000 feet, a 6-foot diameter drogue parachute will be opened to stabilize the craft. At about 10,000 feet, a 63-foot main landing parachute will unfurl from the neck of the craft.

On touchdown, the main chute will be jettisoned. On board electrical equipment will be shut down, and location aids will be activated.

Recovery.—Several new recovery techniques will be tried operationally for the first time in MA-6. If all's well, the astronaut, on leaving the craft via the neck or the side hatch, should be greeted by two frogmen who by that time will have cinched a new flotation belt around the base of the craft. This is to add to the craft's seaworthiness.

Plans call for the frogmen to leap into the water with the quick-inflating belt from one of several recovery helicopters staged off aircraft carriers in the three prime recovery zones. As soon as they have secured the 3-foot-high belt, the astronaut will emerge, grab a "horse collar" lift from a hovering helicopter and be whisked up into the copter and to a nearby carrier.

Meanwhile, a smaller ship is to go alongside the spacecraft and hoist it onto its deck for transfer to the carrier or direct delivery to the Cape.

THE MA-6 MERCURY SPACECRAFT

The MA-6 spacecraft is similar to those used in previous Mercury flights. About as big as a phone booth, the interior looks much like the cockpit of a high-performance airplane—only smaller.

Here are some of the major items confronting the pilot:

Instrument panel.—Instruments are located on a main instrument panel, a left console, and a right console. The main panel is directly in front of the pilot. Navigational and control instruments are located in the left and center sections of the panel and the periscope is located in the center. The right section of the main panel is composed of environmental system gauges and controls, electrical switches, indicators, and communication system controls.

Rate stabilization and control.—Attitude of the Mercury spacecraft is changed by the release of short bursts of superheated steam (hydrogen peroxide) from 18 thrust nozzles located on the conical and cylindrical portions of the craft's surface. Timing and force of these bursts are controlled by one of the following: (1) Automatic stabilization and control system (ASCS), or "Auto-Pilot"; (2) rate stabilization and control system (RSCS), or "rate command" system; (3) the manual proportional control system, a manual-mechanical system, and (4) the fly-by-wire (FBW), a manual-electrical system.

The left console includes sequencing telelights and a warning panel, indicators and controls for the spacecraft's automatic pilot (ASCS), environmental control and landing systems. Altogether, there are over 100 lights, fuses, switches, and miscellaneous controls and displays.

Cameras.—A 16-mm camera is installed to the left of the astronaut's head to photograph the instrument panel display from launch through recovery. A pilot observer camera is mounted in the main instrument panel and will also be operated from launch through recovery.

Periscope.—An earth periscope is located approximately 2 feet in front of the pilot and will provide a 360° view of the horizon. The pilot may manually adjust for "low" or "high" magnification. On "low" he will have a view of the earth of about 1,900 miles in diameter—in "high" the field of view will be reduced to about 80 miles. Altitude can be measured within plus or minus 10 nautical miles. The Mercury-Earth periscope will, in addition, serve as a navigational aid.

Pilot support couch.—The astronaut's couch is constructed of a crushable honeycomb material bonded to a Fiberglas shell and lined with rubber padding. Each astronaut has a flight couch contoured to his specific shape. The couch is designed to support the pilot's body loads during all phases of the flight and to protect him from acceleration forces of launch and reentry.

Restraint system.—The restraint system, which consists of shoulder and a chest strap, leg straps, crotch strap, lap belt, and toe guards, is designed to keep the astronaut in the couch during maximum deceleration.

Environmental control system.—The environmental control system provides the MA-6 spacecraft cabin and the astronaut with a 100-percent oxygen environment to furnish breathing, ventilation, and pressurization gas required during flight. The system is completely automatic, but in the event the automatic control fails, emergency controls can be used.

The system consists of two individual control circuits (the cabin circuit and the suit circuit), which will normally operate for about 28 hours. Both systems are operated simultaneously. The suit circuit is isolated from the cabin circuit by the astronaut closing the face-plate on his helmet. Unless there is a failure in the cabin circuit causing loss of pressure, the pilot's pressure suit will not be inflated.

Aeromedical information.—Throughout the flight, the physical well-being of the pilot will be monitored. The pilot's respiration rate and depth, electrocardiogram, and body temperature will be telemetered to flight surgeons on the ground.

Pilot communications.—The MA-6 astronaut may remain in touch with the ground through the use of high-frequency and ultra-high-frequency radios, radar recovery beacons, and if the situation dictates, a command receiver or a telegraph code key.

Main battery system.—Three 3,000 watt-hour batteries and one 1,500 watt-hour battery are connected in parallel to provide power for the complete mission and about a 12-hour postlanding period. A standby backup power system of 1,500 watt-hour capacity is also provided. To further insure reliable operation of the pyrotechnic system, each device has a completely isolated power feed system.

Retrofire timer.—There will be a timer in the MA-6 spacecraft with three major separate operational components: (1) a standard aircraft elapsed timeclock, (2) a "seconds from launch" digital indicator with a manual reset, and (3) a resettable timer and time-delay relay which will initiate the retrograde fire sequence. When the preset time has passed, the relay closes and actuates the retrograde fire signal, at the same time sending a telemetered signal to the ground.

Altimeter.—The Mercury barometer altimeter is a single-revolution indicator with a range from sea level to 100,000 feet. The dial face has reference marks at the drogue and main parachute deployment altitudes.

At the top right corner of the main panel are located environmental displays, providing the pilot with indications of cabin pressure, temperature, humidity, and oxygen quantity remaining.

Food, water, and waste storage.—*Friendship 7* will carry about 3,000 calories of food—beef and mixed vegetables—and about 6 pounds of water. The water will be in two flat bottles, each fitted with a tube. The food is in two tubes, about the size of tooth paste tubes. In addition, there will be some quick-energy sugar tablets.

Survival equipment.—The survival package will consist of a one-man liferaft, desalting kit, shark repellent, dye markers, first aid kit, distress signals, a signal mirror, portable radio, survival rations, matches, a whistle, and 10 feet of nylon cord.

A new lightweight, radar-reflective liferaft is fabricated of Mylar (for air retention) and nylon (for strength). The 3-pound, 4-ounce raft features three water ballast buckets for flotation stability and a deflatable boarding end which may be reinflated by an oral inflation tube following boarding. The raft, made of the same material used in the Echo satellite balloon, is international orange.

Pilot's map.—A small cardboard diagram of the MA-6 flight path with recovery forces indicated is contained within a bag suspended beneath the periscope. On the reverse side, the pilot's view through the periscope from maximum altitude is shown. Last minute information on cloud formations and weather phenomena will be marked by Mercury weather experts.

Hatch.—The MA-6 spacecraft is equipped with a hatch secured by explosive bolts, just as the pilot's canopy is secured in a high performance aircraft. The astronaut can jettison the hatch by pushing a plunger button inside the spacecraft or by pulling a cable. The hatch may also be removed by recovery teams.

Cylindrical neck contents.—Above the astronaut's cabin, the cylindrical neck section contains the main and reserve parachute system.

Three parachutes are installed in the spacecraft. The drogue chute has a 6-foot-diameter, conical, ribbon-type canopy with ap-

proximately 6-foot-long ribbon suspension lines, and a 30-foot-long riser made of Dacron to minimize elasticity effects during deployment of the drogue at an altitude of 21,000 feet. The drogue riser is permanently attached to the capsule antenna by a three-point suspension system terminating at the antenna in three steel cables, which are insulated in areas exposed to heat.

The drogue parachute is packed in a protective bag and stowed in the drogue mortar tube on top of a lightweight sabot. The sabot functions as a piston to eject the parachute pack when pressured from below by gasses generated by a pyrotechnic charge.

The function of the drogue chute is to provide a backup stabilization device for the spacecraft in the event of failure of the reaction control and stabilization system. Additionally, the drogue chute will serve to slow the capsule to approximately 250 feet per second at the 10,000-foot altitude of main parachute deployment.

The reserve chute is identical to the main chute. It is deployed by a flat circular-type pilot chute.

Other components of the landing system include drogue motor and cartridge, radar chaff, barostats, antenna fairing ejector, sea marker packet, and two underwater charges—one attached to and deployed by the antenna lanyard and the other fixed to the spacecraft.

Following escape tower separation in flight, the 21,000- and 10,000-foot barostats are armed. No further action occurs until the capsule descent causes the 21,000-foot barostat to close and activate power to the drogue mortar which ejects the drogue as well as the radar chaff, loosely packed under the drogue chute, to provide a target for radar location.

Two seconds after the 10,000-foot barostat closes, power is supplied to the antenna fairing ejector, located above the cylindrical neck section, to deploy the main landing parachute and an underwater charge, which is dropped to provide an audible sound landing point indication. The ultrahigh frequency SARAH radio then begins transmitting. A can of seamarker dye is deployed with the reserve chute and remains attached to the spacecraft by a lanyard.

On landing, an impact switch jettisons the landing parachute and initiates the remaining location and recovery aids. This includes release of sea marker dye with the reserve parachute if it has not previously been deployed, triggering a high-intensity flashing light, extension of a 16-foot whip antenna and the initiation of the operation of a high-frequency radio beacon.

If after landing, the spacecraft should spring a leak or if the life support system should become fouled after landing, the astronaut can escape through this upper neck section or through the side hatch.

Impact skirt.—Following deployment of the main landing parachute, the heat shield is released, extending the landing-impact bag to form a pneumatic cushion primarily for impact on land, it is also required for capsule stability after water landings.

The air cushion is formed by a 4-foot skirt made of rubberized fiberglass that connects the heat shield and the rest of the capsule. After the main parachute is deployed, the heat shield is released from the capsule and the bag fills with air. Upon impact, air trapped between the heat shield and the capsule is vented through holes in the skirt as well as portions of the capsule which are not completely air tight, thereby providing the desired cushioning effect.

THE ATLAS LAUNCH VEHICLE

The launch vehicle to be used for the Mercury-Atlas 6 test is an Atlas D model, one of several Atlases especially modified for use in the Mercury flight test program. This vehicle develops 360,000 pounds of thrust and burns Rp-1, a kerosenelike fuel, and liquid oxygen.

Principal differences in the Mercury-Atlas and the military version of the vehicle include (1) modification of the payload adapter section to accommodate the Project Mercury spacecraft, (2) structural strengthening of the upper neck of the Atlas to provide for the increase in aerodynamic stress imposed on the Atlas when used for Mercury missions, and (3) inclusion of an automatic abort sensing and implementation system (ASIS) designed to sense deviations in the performance of the Atlas and trigger the Mercury escape system before an impending catastrophic failure.

The Atlas measures 65 feet from its base to the Mercury adapter section and is 10 feet in diameter at the tank section. With adapter section, spacecraft and escape tower, the Mercury-Atlas stands 93 feet tall.

The Atlas is constructed of thin-gage metal and maintains structural rigidity through pressurization of its fuel tanks. For this flight, the Atlas will have a heavier gage skin at the forward end of the liquid oxygen tank, the same as that used in other launches of Atlas space systems.

All five engines are ignited at the time of launch—the sustainer (60,000 pounds thrust), the two booster engines (150,000 pounds thrust each) which are outboard of the sustainer at the base of the vehicle and two small vernier engines which are used for minor course corrections during powered flight. During the first minute of flight, it consumes more fuel than a commercial jet airliner during a trans-continental run.

ASTRONAUT PARTICIPATION

All seven of Project Mercury's team of astronauts will participate in the MA-6 orbital mission, some as flight controllers from far-flung vantage points around the globe.

Astronauts John H. Glenn, Jr., prime pilot, M. Scott Carpenter, backup pilot, and Alan B. Shepard, Jr., technical adviser, will be at Cape Canaveral. Astronaut Walter M. Schirra, Jr., will be stationed at the Mercury site at Point Arguello, Calif., and Astronaut L. Gordon Cooper, Jr., will participate from the Mercury tracking station in Murcha, Australia. Astronaut Virgil I. "Gus" Grissom will monitor launch, insertion, landing, and recovery from Mercury's Bermuda station, while Donald K. Slayton will perform spacecraft checkout prior to insertion of the mission pilot.

THE NETWORK

Worldwide Mercury tracking stations, including ships in the Indian and Atlantic Oceans, will monitor the MA-6 flight. The Space Computing Center of the NASA Goddard Space Flight Center in Greenbelt, Md., will make trajectory computations.

During the flight, information will pour into the Space Computing Center from tracking and ground instrumentation points around the

globe at the rate, in some cases, of more than 1,000 bits per second. Upon almost instantaneous analysis, the information will be relayed to the Cape for action.

In addition to proving man's capability for surviving in and performing efficiently in space, and since only two other flights have been made along the worldwide tracking network, the test will further evaluate the capability of the network to perform tracking, data-gathering, and flight control functions.

The Mercury network, because of the man factor, demands more than any other tracking system. Mercury missions require instantaneous communication.

Tracking and telemetered data must be collected, processed, and acted upon in as near "real" time as possible. The position of the vehicle must be known continuously from the moment of liftoff.

After injection of the Mercury spacecraft into orbit, orbital elements must be computed and prediction of "look" information passed to the next tracking site so the station can acquire the capsule.

Data on the numerous capsule systems must be sent back to earth and presented in near actual time to observers at various stations. And during the recovery phase, spacecraft impact location predictions will have to be continuously revised and relayed to recovery forces.

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Other stations in the continental United States are at Point Arguello in southern California; White Sands, N.Mex.; Corpus Christi, Tex.; and Eglin, Fla. One station is located on Kauai Island in Hawaii.

There are two radar picket ships. The Atlantic ship *Rose Knot* will be stationed on the equator near the west African coast. The

Indian Ocean ship *Coastal Sentry* will be located midway between Zanzibar and Muchea, Australia.

Stations at overseas sites include one on the south side of Grand Canary Island, 120 miles west of the African coast; Kano, Nigeria, in a farming area about 700 rail miles inland; Zanzibar, an island 12 miles off the African coast in the Indian Ocean; two in Australia—one about 40 miles north in Perth, near Muchea, and the other near Woomera; Canton Island, a small coral atoll about halfway between Hawaii and Australia; one in Mexico, near Guaymas on the shore of the Gulf of Mexico; and one in Bermuda, an independent, secondary control center.

Some 20 private and public communications agencies throughout the world provide leased land lines and overseas radio and cable facilities.

Site facilities include equipment for acquiring contact with the spacecraft; long-range radars for automatic tracking; telemetry equipment for receiving data on the spacecraft and the astronaut; command control equipment for controlling the manned vehicle from the ground, if necessary, and voice channels for ground-to-air communications. The extensive ground communications system interconnects all stations through Goddard and the Mercury control at Cape Canaveral.

Sites equipped with tracking radars have digital data conversion and processing equipment for preparing and transmitting information to the computing system without manual processing, marking a significant achievement—global handling of data on a real-time basis.

One function of the computer is to transmit information regarding the spacecraft's position to Mercury Control Center at the Cape, where it is displayed on the world map in the operations room. The computer also originates acquisition information which is automatically sent to the range stations.

During every major Mercury launch, the attention of some 15 NASA flight controllers is focused on dozens of consoles and wall displays in the Mercury Control Center operations room. This room is the control point for all information that will flow through the worldwide tracking and communications system. In this room NASA flight controllers make all vital decisions required, and issue or delegate all commands.

In the 50-foot-square room, about 100 types of information register at various times on the indicators of the consoles and the high range-status map. Of these 100 quantities, 10 show biomedical condition, approximately 30 relate to life support facilities, and about 60 give readings on spacecraft equipment. This information flows in on high-speed data circuits from computers at the Goddard Center, on direct teletype circuits from remote sites, and by booster and spacecraft telemetry relayed over radio and wire circuits.

Three kinds of data start pouring into the computing system as soon as the booster lifts half an inch off the launch pad:

1. *Radar data.*—Triggers the Cape Canaveral IBM 7090 which monitors the spacecraft's flight path and predicts its impact point if the mission must be aborted.
2. *Guidance data.*—Radioed from the spacecraft to a special-purpose computer at the cape.
3. *Telemetry data.*—Reports check points, e.g., liftoff, booster separation.

These data are transmitted from Cape Canaveral to Goddard where IBM 7090's compare the spacecraft trajectory to a predetermined flight path, and flash the results back to Canaveral. This is a "real time" operation—that is, the system receives, moves it over 2,000 miles, analyzes, predicts, and displays data so fast that observers and controllers follow events as they happen.

COMMUNICATIONS INFORMATION

The system carries telephone, teletype, and high-speed data (1,000 bits per second) information. It can accept a message from a distant site and deliver it to the final destination, regardless of location, in a little over 1 second.

Radio teletype facilities use single sideband transmitters, which are less susceptible to atmospheric interference. All circuits, frequencies, and paths were selected only after a careful study of data accumulated over 25 years by the National Bureau of Standards on the various propagation qualities of many radio paths.

Submarine cables to London (via New York), to Hawaii (via San Francisco), and to Australia (via Vancouver, B.C.) are included in the Mercury communications network.

The Mercury Voice Network has a twofold mission:

1. Provide Mercury Control Center (MCC) with "real time" information from worldwide tracking stations having the orbiting Mercury spacecraft in view.
2. Provide a rapid means for dealing with emergency situations between MCC and range stations during a mission.

The network is essentially a private line telephone system radiating from GSFC to MCC and the project's world sites.

These lines are used during an orbit mission to exchange verbal information more rapidly than can be done by teletype. Conversations are recorded both at Goddard and Mercury Control Center for subsequent playback. When not used for orbit exercises, the circuits are utilized for normal communications operations.

ASTRONAUT TRAINING PROGRAM SUMMARY

Here are some of the general training activities that the Project Mercury astronauts have undergone since May 1959.

1. *Systems and vehicle familiarization.*—The seven astronauts were given lectures in the vehicle systems by NASA and several of the contracting companies. NASA Langley Research Center gave them a 50-hour course in astronautics. McDonnell Aircraft Corp. engineers talked to the astronauts on Mercury subsystems. Lectures were given to the astronauts by Dr. William K. Douglas on aeromedical problems of space flight. At the Navy centrifuge in Johnsville, Pa., the astronauts flew the Mercury acceleration profiles. At several Air Force bases they flew brief zero-gravity flight paths. Checkouts of the Mercury environmental system and the pressure suit were accomplished at the Navy Air Crew Equipment Laboratory in Philadelphia. At the Naval Medical Research Institute they became familiar with the physiological effects of high CO₂ content in the environment. The Army Ballistic Missile Division and its associated contractors indoctrinated them on the Redstone. The Air Force

Space Systems Division and its associated contractors told the astronauts about the Atlas launch vehicle.

2. *Star recognition.*—Each astronaut periodically received concentrated personal instruction on the elements of celestial navigation and on star recognition at the Morehead Planetarium, Chapel Hill, N.C. A trainer simulating the celestial view through a spacecraft window permitted astronaut practice in correcting yaw drift.

3. *Desert survival.*—A 5½-day course in desert survival training was carried out at the USAF Training Command Survival School at Stead Air Force Base, Nev. The course consisted of survival techniques through lectures, demonstrations, and application in a representative desert environment. The Mercury survival kit was also evaluated during this period.

4. *Egress training.*—During March and April 1960, open water normal egress training was conducted in the Gulf of Mexico off Pensacola, Fla. Each astronaut made at least two egresses through the upper hatch (up to 10-foot swells were experienced). Water survival training was also accomplished in August 1960 and December 1961 at Langley. Each of the astronauts made underwater egresses, some of which were made in the Mercury pressure suit.

5. *Specialty assignments.*—The astronauts contributed to the Mercury development program by working directly with Manned Spacecraft Center engineers and by attending NASA-McDonnell coordination meetings and booster panel meetings in their specialty areas. Astronaut specialty areas are—

Carpenter: Communications equipment and procedures, periscope operation, navigational aids and procedures.

Cooper: Redstone booster, trajectory aerodynamics, countdown, and flight procedures, emergency egress, and rescue.

Glenn: Cockpit layout, instrumentation, controls for spacecraft, and simulation.

Grisson: Reaction control system, hand controller, autopilot, and horizon scanners.

Schirra: Environmental control systems, pilot support and restraint, pressure suit, aeromedical monitoring.

Shepard: Recovery systems, parachutes, recovery aids, recovery procedures, and range network.

Slayton: Atlas booster and escape system including Atlas configuration, trajectory, aerodynamics, countdown, and flight procedures.

MERCURY LAUNCH CHRONOLOGY

Two types of Mercury spacecraft have been used in the flight-test program. First series of shots used full-scale "boilerplate" models of the capsule to check out booster-spacecraft integration and the escape system. Second phase of the development firing program used Mercury capsules built to production standards.

This is the chronology of test firings:

September 9, 1959.—Big Joe. NASA-produced research and development capsule, launched on an Atlas from Cape Canaveral—test validation of the Mercury concept. Capsule, survived high heat and airload and was successfully recovered.

October 4, 1959.—Little Joe 1. Fired at NASA's Wallops Station, Va., to check matching of booster and spacecraft. Eight solid-

propellant rockets producing 250,000 pounds of thrust drove the vehicle.

November 4, 1959.—Little Joe 2. Also fired from Wallops Station, was an evaluation of the low-altitude abort conditions.

December 4, 1959.—Little Joe 3. Fired at Wallops Station to check high-altitude performance of the escape system. Rhesus monkey Sam was used as test subject.

January 21, 1960.—Little Joe 4. Fired at Wallops Station to evaluate the escape system under high airloads, using Rhesus monkey Miss Sam as a test subject.

May 9, 1960.—Beach Abort Test. McDonnell's first production capsule and its escape rocket system were fired in an off-the-pad abort escape rocket system (capsule 1).

July 29, 1960.—Mercury-Atlas 1. This was the first Atlas-boosted flight, and was aimed at qualifying the capsule under maximum airloads and afterbody heating rate during reentry conditions. The capsule contained no escape systems and no test subject. Shot was unsuccessful because of booster system malfunction (capsule 4).

November 8, 1960.—Little Joe 5. This was another in the Little Joe series from Wallops Station. Purpose of the shot was to check the production capsule in an abort simulating the most severe Little Joe booster and the shot was unsuccessful (capsule 3).

November 21, 1960.—Mercury-Redstone 1. This was the first unmanned Redstone-boosted flight, but premature engine cutoff activated the emergency escape system when the booster was only about 1 inch off the pad. The booster settled back on the pad and was damaged slightly. The capsule was recovered for reuse (capsule 2).

December 19, 1960.—Mercury-Redstone 1A. This shot was a repeat of the November 21 attempt and was completely successful. Capsule reached a peak altitude of 135 statute miles, covered a horizontal distance of 236 statute miles, and was recovered successfully (capsule 2).

January 31, 1961.—Mercury-Redstone 2. This was the Mercury-Redstone shot which carried Ham, the 37-pound chimpanzee. The capsule reached 155 statute miles altitude, landed 420 statute miles downrange, and was recovered. During the landing phase, the parachuting capsule was drifting as it struck the water. Impact of the angle blow slammed the suspended heat shield against a bundle of potted wires, which drove a bolt through the pressure bulkhead, causing the capsule to leak. Ham was rescued before the capsule had taken on too much water (capsule 5).

February 21, 1961.—Mercury-Atlas 2. This Atlas-boosted capsule shot was to check maximum heating and its effect during the worst reentry design conditions. Peak altitude was 108 statute miles; reentry angle was higher than planned and the heating was correspondingly worse than anticipated. It landed 1,425 statute miles downrange. Maximum speed was about 13,000 miles per hour. Shot was successful (capsule 6).

March 18, 1961.—Little Joe 5A. This was a repeat of the unsuccessful Little Joe 5; it was fired at Wallops Station and was only marginally successful (capsule 14).

April 25, 1961.—Mercury-Atlas 3. This was an Atlas-boosted shot attempting to orbit the capsule with a "mechanical astronaut" aboard.

But 40 seconds after launching the booster was destroyed by radio command given by the range safety officer. The capsule was recovered and will be fired again (capsule 8).

April 28, 1961.—Little Joe 5B. This was the third attempt to check the escape system under worst conditions, using a Little Joe booster fired from Wallops Station. Capsule reached 40,000 feet, and this time the shot was a complete success (capsule 14).

May 5, 1961.—Mercury-Redstone 3. This Redstone-boosted shot carried Astronaut Alan B. Shepard, Jr., on a ballistic flight path reaching a peak altitude of 116 statute miles and a downrange distance of 302 statute miles. Flight was successful (capsule 7).

July 21, 1961.—Mercury-Redstone 4. This successful flight carried Astronaut Virgil I. "Gus" Grissom to an altitude of 118 statute miles and 303 miles downrange. The capsule sank despite helicopter recovery efforts (capsule 11).

September 13, 1961.—Mercury-Atlas 4. This successful flight saw the spacecraft attain orbit for the first time. The craft carried a "crewman simulator" designed to use oxygen and put moisture into the cabin at about the same rate as a man. Craft was recovered as planned about 160 miles east of Bermuda after one orbit (capsule 8).

November 29, 1961.—Mercury-Atlas 5. The flight successfully carried the chimpanzee Enos through two orbits to a smooth landing. The craft was recovered about 260 miles south of Bermuda (capsule 9).

after we finished a recording, we finally had copies of the on-board recorder tape and we played these over last night rather late and went through the recording.

And Al came on the air just as the start of this communication and started to tell us his version this and the people that were listening with me said that this is --

APPENDIX J

ADVANCED MANNED SPACE FLIGHT, MERCURY, GEMINI, AND APOLLO

At the request of the chairman of the Senate Committee on Aeronautical and Space Sciences, the Administrator of the National Aeronautics and Space Administration, Mr. James E. Webb, submitted the following statement with respect to the follow-on to the Mercury program, as it is now generally understood.

"MERCURY

"Project Mercury is the initial step in the National Aeronautics and Space Administration's manned space flight program. Its purpose is to determine man's capabilities in the space environment and to develop the technology required for manned space flight missions. The original objective of the program was to orbit an astronaut three times around the world and return him safely to earth. This was accomplished in the February 20, 1962, flight of Astronaut John H. Glenn, Jr. The Mercury program is not, however, considered completed as of this time. Mercury capsules are being modified to accomplish manned missions of 1 day duration. Several additional missions are planned this calendar year in the Mercury program, and these will make the maximum use of the Mercury system, exposing man to extended periods, up to 24 hours, in the space environment.

"GEMINI

"This program will follow the manned 1-day flights. The program resulted from a decision to initiate the development of a rendezvous-in-earth-orbit technique as a means of achieving manned lunar landing. Gemini will use an advanced two-man Mercury-type space capsule. The purpose of the program is to produce the necessary experience in rendezvous techniques through practice of rendezvous and docking maneuvers with a modified Agena booster.

"APOLLO

"The follow-on program to Mercury and Gemini is called project Apollo. The ultimate mission of Project Apollo is to achieve manned lunar landing and return to earth. It will be developed from the data developed in these earlier projects. Apollo spacecraft will be modular, the crew will be housed in a command module, a service unit will contain support and various propulsion systems, and a lunar landing module will be added to land the command and service modules on the moon."

Answer: Well, I think that this gets into a little different area. I'm qualified to comment on right now. We may have to discuss

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NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Public Information Office, Cocoa Beach, Florida

FOR RELEASE: 5 P.M.

February 12, 1962

WORD ONE/KEYSEARCH

D:02-12-62

PAO N:00 G:MER

MA-6 Advisory

PAO ROB:ZA

MA-6 Advisory

Although the forecast was for marginal weather in several downrange recovery areas, all other elements of the MA-6 manned orbital flight launch operation reported ready for a launch attempt not earlier than Wednesday, February 14, 1962.

During a prelaunch mission review at the NASA Manned Spacecraft Center's Cape Canaveral headquarters, the Atlas, Mercury spacecraft, worldwide tracking range, recovery forces, control center and the pilot were reported in a "go" condition for the launch.

While the meeting was underway at Cape Canaveral, Astronaut John Glenn was at Patrick AFB Hospital undergoing the first half of a two-part physical examination. The examination included electro-encephalograph and electro cardiograph recordings and thorough examination of the eyes, ears, nose and throat.

Astronaut M. Scott Carpenter, who had acted as the pilot in the Mercury Spacecraft Procedures trainer during a mission simulation this morning, attended the mission review meeting as Glenn's representative.

Glenn was expected to be back at Cape Canaveral by about 5 P.M. and planned to take his regular daily run. He planned to spend the evening reviewing flight plans and other technical reports and to retire early.



U.S. Weather Bureau representatives forecasted possible increased cloudiness, high winds and rough seas in the recovery areas along part of the first orbit flight path across the Atlantic.

Project Mercury Operations Director Walter C. Williams advised the members of the Mercury operational team that he would continue to watch the weather situation and would make his launch decision on the most current weather available as the countdown begins.

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February 16, 1962

The following is a NASA press pool dispatch: by Vern Haugland, aboard the Antietam, February 16, -- (AP) -- Mercury Capsule no. 18 capsized and bobbed along upside down on waves 10 feet high today -- mute evidence of the dangers of landing a space capsule in rough water. Number 18 is a full scale replica of the craft in which John Glenn hopes to orbit the earth. Its size and shape are those of Glenn's capsule, and its weight about that of the Mercury craft as it returns to earth, but number 18 has no instruments or internal fittings. It is meant for training purposes only. In a practice maneuver 300 miles south of Bermuda, a helicopter piloted by Marine Capt. Robert L. Kemble, McAllen, Texas, picked the capsule up off the Antietam's deck. Lt. Donald A. Hodgen, Ashland, Oregon, copilot, leaned out the helicopter door while Kemble hovered the chopper over the capsule using a 12-foot long aluminum pole with a hook on the end, Hodgen fastened a cable from the helicopter to the capsule as easily as a boy spearing a fish. Kemble flew about two miles ahead of the Antietam and, from a low level, dropped the capsule into the water. Instead of floating upright like a cork as it usually does, the capsule flopped over so that its cone-shaped neck, with the escape hatch, was under water and its broad, blunt bottom and cushioning skirt were exposed. Had the capsule contained a man he would certainly have been most uncomfortable -- and in danger of suffocating or drowning. In its inverted position the capsule could not be fished out by helicopter, and there was a possibility it might sink. One of the divers attached to the Mercury program said that once before, in a trial in the Gulf of Mexico, a capsule tipped over. It was found later that a 500-pound weight inside the capsule, used as ballast had shifted, changing the center of gravity. After that we welded the metal sheets in there, and they shouldn't have broken loose he said. Because the capsule was riding upside down, it could not be fished out by helicopter. The Antietam launched a whaleboat which approached the dangerously bobbing capsule and sent two skindivers

to attach a towing rope to it. After the capsule had been hauled back aboard, experts of the National Aeronautics and Space Administration inspected it. Lee Foster, NASA engineer at Langley Field, Va., said the trouble was that the craft had been dropped into the water so gently that its skirt billowed full of air, like a balloon, and tipped the capsule over. Foster said a capsule descending by parachute after orbiting the earth would hit so hard that it would collapse the skirt so quickly that the skirt would merely provide the desired cushioning effect without the unwanted tilting force. Nevertheless the incident showed what could happen if a spacecraft landed on the steep slope of a heavy wave --- and why Project Mercury Directors are determined to wait for the safest water landing conditions possible before rocketing an astronaut around the earth.

--- some evidence of the dangers of landing in rough water. Number 18 is a full scale replica of the craft in which John Glenn hopes to orbit the earth. Its size and shape are those of Glenn's capsule, and its weight about that of the Mercury craft as it returns to earth, but number 18 has no instruments or internal fittings. It is meant for training purposes only. In a practice maneuver 300 miles south of Bermuda, a helicopter piloted by Marine Capt. Robert L. Kemble, McAllen, Texas, picked the capsule up off the Antietam's deck. Lt. Donald A. Hodgson, Ashland, Oregon, co-pilot, leaned out the helicopter door while Kemble hovered the chopper over the capsule using a 12-foot long aluminum pole with a hook on the end. Hodgson fastened a cable from the helicopter to the capsule as easily as a boy spearing a fish. Kemble flew about two miles ahead of the Antietam and, from a low level, dropped the capsule into the water. Instead of floating upright like a cork as it usually does, the capsule flipped over so that its cone-shaped neck, with the escape hatch, was under water and its broad, blunt bottom and cushioning skirt were exposed. Had the capsule contained a man he would certainly have been uncomfortable --- and in danger of suffocating or drowning. In its inverted position the capsule could not be fished out by helicopter, and there was a possibility it might sink. One of the divers attached to the Mercury program said that once before, in a trial in the Gulf of Mexico, a capsule tipped over. It was found later that a 500-pound weight inside the capsule, used as ballast had shifted, changing the center of gravity. After that we weighed the metal sheets in there, and they shouldn't have broken loose he said. Because the capsule was riding upside down, it could not be fished out by helicopter. The Antietam launched a whaleboat which approached the dangerously bobbing capsule and sent two skin divers



NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Public Information Office, Cocoa Beach, Florida

FOR RELEASE: February 19, 1962
9:00 A.M., EST

D:02-19-62 PAO N100 G MER MA-6 Advisory PAO ROB12A
Mercury Atlas 6

WORD ONE/KEYSEARCH MA-6 Advisory

The first half of the split, two-day countdown in preparation for the MA-6 first manned orbital launch attempt was started at 2:30 a.m. this morning. As of about 6 a.m., the pre-count had been completed satisfactorily and both the Atlas and Friendship 7 spacecraft were in a "GO" condition.

Project officials planned to monitor weather throughout the day, make a complete review of the weather situation tonight to include on-scene reports from U.S. Navy ships in the recovery areas and make a preliminary go, no-go decision at about midnight.

The weather forecast for Tuesday morning prepared as of 8:00 a.m. this morning is as follows:

Generally much improved conditions are indicated for the Atlantic ocean for Tuesday with only a small part of the ocean area expected to be of much concern. A cold front preceded by a squall line is advancing into northern Florida this morning and will set off showers and thunderstorms over the central parts of the state this afternoon and evening. The squall line is expected to move through the Cape Canaveral area but the front is predicted to lie across central Florida tomorrow morning and cloudiness may linger in the Cape area through the morning.

Maximum winds in the Atlantic Ocean are not expected to exceed 20 to 25 knots. Some seas of six to eight feet are likely from decaying waves of storms far to the north of the Mercury track.

Cape Canaveral -- broken cloudiness, gentle winds and slight seas.

Cape to Bermuda -- partly cloudy, moderate to fresh winds, increasing seas around Bermuda but not expected to exceed about five feet.

Remainder of the Atlantic -- moderate to fresh winds, moderate seas, with worst conditions in the central Atlantic.

End of first orbit -- partly cloudy, moderate winds and seas.

NEWS RELEASE

- 2 -



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

End of second orbit -- partly cloudy, moderate wind and slight sea.

End of third orbit -- partly cloudy gentle wind and slight sea.

Other areas around the world -- no known weather conditions likely to effect the MA-6 mission.

The launch attempt for the first manned orbital flight is planned for not earlier than Tuesday morning, February 20, 1962.

Project officials planned to monitor weather from the day, make a complete review of the weather situation tonight to include on-scene reports from U.S. Navy ships in the recovery area and make a preliminary go, no-go decision at about midnight.

The weather forecast for Tuesday morning prepared as of 6:00 a.m. this morning is as follows:

Generally much improved conditions are indicated for the Atlantic ocean for Tuesday with only a small part of the ocean area expected to be of much concern. A cold front preceded by a squall line is advancing into northern Florida this morning and will set off showers and thunderstorms over the central parts of the state this afternoon and evening. The squall line is expected to move through the Cape Canaveral area but the front is predicted to lie across central Florida tomorrow morning and cloudiness may linger in the Cape area through the morning.

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End of first orbit -- partly cloudy, moderate winds and seas.



NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Public Information Office, Cocoa Beach, Florida

FOR RELEASE: February 19, 1962
5:00 p.m., EST

MA-6 Advisory

During a mid-afternoon mission review, Mercury Operations Director Walter C. Williams was advised that the Atlantic recovery area weather appeared favorable for the MA-6 mission. However the movement of a frontal system across central Florida will likely cause broken cloudiness in the Cape Canaveral area Tuesday morning.

Astronaut John Glenn spent the morning reviewing the first half of the split countdown which was completed at 6 this morning. He visited his regular barber in Cocoa Beach just before lunch.

After lunch, he reviewed flight plan material and equipment lists before attending a mid-afternoon mission review. All systems in the MA-6 vehicle, the world-wide tracking network and the recovery forces were reported ready for a launch attempt as early as tomorrow morning.

Williams ordered the launch crew to begin the countdown at 11:30 p.m. tonight, barring unforeseen weather developments between now and then.

* * *



NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Public Information Office, Cocoa Beach, Florida

FOR RELEASE: February 15, 1962
5:00 p.m.

MA-6 Advisory

After being informed of the postponement of the MA-6 launch attempt early this morning, Astronaut John Glenn went back to bed and slept until about 9:30 a.m. today.

Glenn spent about 2 hours in the Mercury Procedures trainer at the Mercury Control Center this morning, practicing launch operations, retro-rocket firing exercises and emergency procedures. After lunch he spent some time reviewing flight plans and technical data material regarding the MA-6 mission.

While discussing the postponement of the MA-6 mission this afternoon, Glenn said, "This mission has been in preparation for a long time. I can't get particularly shook up about a couple days' delay. As a matter of fact, I'm so happy to have been chosen to be the pilot for this mission that I'm not about to get panicky over these delays. I learned very early in the flight test business that you have to control your emotions -- you don't let these kinds of things throw you or effect your ability to perform the mission!"

Glenn said he planned to take a short run later this afternoon, to have dinner and go to bed early.

U.S. Weather Bureau representatives this afternoon advised that the weather in the central and western Atlantic continues to be disturbed. One storm in the Central Atlantic appears to be moving north off the Mercury track.

The weather front which has effected the weather in the area near the end of the first orbit should move south but the sea conditions in that area will continue to be moderate to rough.

There is a possibility of more cloud cover in the launch area tomorrow morning than has been the case either yesterday or today.

Mercury Operations Director Walter C. Williams will review the weather situation again about midnight before making a go-no go decision on a launch attempt tomorrow morning.

WORD ONE/KEYSEARCH

* * *

D:02-15-62 PAO N100 G-MER MA-6 Advisory PAO R28012
Mercury Atlas-6

NASA PERSONNEL TO GRAND TURK OR BERMUDA

		ARRIVAL	GRAND TURK DEPARTURE
R. R. Gilruth	NASA-MSC	F+1 Day	F+3 Days
W. C. Williams	NASA-MSC	F+1 Day	F+3 Days
A. B. Shepard, Jr.	NASA-MSC	F Day	F+3 Days
D. K. Slayton	NASA-MSC	F Day	F+3 Days
M. Carpenter	NASA-MSC	F Day	F+3 Days
V. I. Grissom	NASA-MSC	F Day	F+3 Days
W. M. Schirra	NASA-MSC	F Day	F+3 Days
Lt/Col W. A. Douglas	NASA-MSC - USAF	F Day	F+3 Days
George Ruff	Civilian	F Day	F+3 Days
H. I. Johnson	NASA-MSC	F Day	F+3 Days
R. B. Voas	NASA-MSC	F Day	F+3 Days
H. A. Kuehnel	NASA-MSC	F Day	F+3 Days
Col. K. Lindell	USAF	F-3 Days	F+3 Days
Capt. W. Augerson	USA	F Day	F+3 Days
Capt. Graybiel	USN	F-2 Days	F+2 Days
Lt. Col. Knoblock	USA	F-2 Days	F+2 Days
Lt. Col. Culver	USAF	F-2 Days	F+2 Days
Lt. Col. Myers	USAF	F-2 Days	F+2 Days
Staff Sg. Stewart	USAF	F-2 Days	F+2 Days
L. Davis	NASA	F-2 Days	F+3 Days
Lt. Col. J. Powers	USAF - NASA	F Day	F+3 Days
E. Horton	NASA	F Day	F+3 Days
D. Conger	NASA	F Day	F+1 Day
Leo Davis	NASA-LOD	F-24 hrs	F+3 DAYS

GRAND TURK

ARRIVAL DEPARTURE

R. Mittaver	NASA	F Day	F+1 Day
W. Taub	NASA	F Day	F+3 Days
W. Hayes	NASA	F Day	F+1 Day
E. Harrin	NASA	F Day	F+1 Day
MAC Capsule Technician		F Day	F+1 Day
LARRY SUMMERS	NASA	F Day	F+1 Day
B. G. Edmonds	NASA	F Day	F+1 Day
C. Buckley	NASA	F Day	F+3 Days
Dr. Shelly Korchin	National Institute of Health		
Flight crew from C-124 airplane			
About eight (8) men. (Questionable)			

BMD SUGGESTED AGENDA FOR NASA MIS ES-24 MEETING

- I. Conference introduction - BMD
- II. Explanation of Conference agenda and introduction of participating BMD, MTC, and STL personnel - BMD
- III. NASA Introduction - Participating NASA personnel introduced, NASA ES-24 test objectives, payload characteristics, and program management concepts broadly defined - NASA.
- IV. description of BMD management structure for BMD support of ES-24 - BMD.
- V. NASA management and technical direction concepts for integrated vehicle NASA.
- VI. Sub-group meetings on specific problem areas:
 - (a) Funding and contracting problems. - *Dryden & Glennan want explanation*
 - (b) Security problems
 - (c) Test requirements, facilities, stand allocation, GBL requirements.
 - (d) Trajectory, dispersion, and guidance
 - (e) Airframe and control system
 - (f) Propulsion
- VII. Group critique ~~statement~~
 - (a) findings of subcommittees summarized
 - (b) Realistic schedules defined
 - (c) NASA-BMD agreements summarized
 - (d) Approximate schedule set up for future conferences.

VIII. *Arrangements for MAC-Convair contacts*

NEWS MEDIA POOL POSITIONS
MERCURY-ATLAS 6

CAPE CANAVERAL

Hangar S T - 120 min.

This is the first position where you view the Astronaut suited up boarding the transfer van for trip to pad.

TV Unit #1

1 Video mobile unit with camera

1 Voice Commentator _____

6 to 8 Technicians

Newsreels

1 Cameraman _____

1 Soundman _____

Still Photographers

1 Black-and-white _____

1 Color _____

1 Stereo _____

Writers

Wire Service

1. _____

2. _____

Periodicals

1. _____

Newspapers

1. _____

TV mobile unit #1 video tapes the transfer van trip from Hangar S to the pad. The rest of the press will follow in station wagons to pad 14.

AFMTC film courier, _____ will take film directly to south gate for still pool to pick up.

NASA escort _____

PAD 14

Launch complex T - 100 min.

Here is where the press views from ground level the astronaut leaving the transfer van, board the elevator to the 11th deck for insertion into spacecraft.

TV Unit #2

Commentator _____

Mobile Unit #2 truck already in position at pad 14 will pick up the transfer van to continue the TV coverage. The hangar S TV Unit #1 will proceed to Road Block 17, intersection of heavy launch road and pad 12.

The newsreels, still photographers and writers are the same as Hangar 3 pool.

AFMTC film courier will take film directly to south gate _____.

NASA escort _____ at T - 60 min. the pool leaves pad area.

ROAD BLOCK 17

T - 60 min. through launch. A visual position only to photograph the launch. The closest position within safety regulation.

TV Unit #2

Pad 14 mobile unit #2 assumes this position, sending the hangar 3 Unit #1 that was standing by to the abort area.

Commentator _____

Newsreels

1. Cameraman _____
2. Soundman _____

Still Photographers

1. Black-and-white _____
2. Color _____
3. Stereo _____

AFMTC escort to courier film _____.

AFMTC escort to stay with pool _____.

ABORT AREA

T - 60 min. through launch. This is the forward medical area in case of an off the pad abort, this position (choppers, doctors and rescue squad etc.) would retrieve the spacecraft and astronaut. Abort area pool is the same as Hangar 3 and pad 14.

TV Unit #1

Commentator _____

Newsreels

1. Cameraman _____
2. Soundman _____

Still Photographers

1. Black-and-white _____
2. Color _____
3. Stereo _____

Writers

Wire Service

1. _____
2. _____

Periodicals

1. _____

Newspapers

1. _____

CONFIDENTIAL

Report No.
TOR-930(2101)-3
Page ii

DETAILED TEST OBJECTIVES
FOR
NASA MISSION MA-6

Prepared by

J. R. Carroll

Flight Test Planning and Data Evaluation
Mercury Atlas Launch Vehicle Program Office
Aerospace Corporation

Approved

B. A. Hohmann

Program Director
Mercury Atlas Launch Vehicle
Aerospace Corporation

Approved

Robert H. Brundin

Lt Colonel, USAF
Director of Mercury, Launch Vehicles
Space Systems Division (AFSC)

Approved

R. R. Gilruth

Director
NASA Manned Spacecraft Center

CONFIDENTIAL

Second orbit recovery area

Ship _____
NASA PIO _____
NASA Photographer _____

TV Film only 16 mm

Cameraman _____
Soundman _____
Voice _____

Newsreels

1. Cameraman _____
2. Soundman _____

Still Photographers

1. Black & White _____
2. Color _____
3. Stereo _____

Writers

Wire Service

1. _____
2. _____

Periodicals

1. _____

First orbit recovery area

Ship _____
NASA PIO _____
NASA Photographer _____

TV Film only 16 mm

Cameraman _____
Soundman _____
Voice _____

Newsreels

1. Cameraman _____
2. Soundman _____

Still Photographers

1. Black & White _____
2. Color _____
3. Stereo _____

Writers

Wire Service

1. _____
2. _____

Periodicals

1. _____

CANARY ISLAND

Recovery area for abort before insertion into orbit.

Ship _____
NASA Photographer _____

Newsreels

1. _____
2. _____

Writers

1. _____
2. _____

Still Photographers

1. Black & White _____
2. Color _____
3. Stereo _____

Periodicals

1. _____

GRAND TURK ISLAND

NASA PIO from carrier will fly to island along with Dean Conger, NASA photographer to cover astronaut's post flight debriefing.

TV film unit Hangar 8 pool flies to Grand Turk Island after launch.

Cameraman _____
Sound _____
Voice _____

} TV Unit flies to Grand Turk Island several days before launch.

Newsreels

1. Cameraman _____
- 2/ Soundman _____

Still Photographers

1. Black & White _____
2. Color _____
3. Stereo _____

Writers

Wire Service

1. _____
2. _____
3. _____

Periodicals

1. _____
2. _____
3. _____

7

THE WHITE HOUSE
WASHINGTON

FILE COPY

~~SECRET~~

May 3, 1963

NATIONAL SECURITY ACTION MEMORANDUM NO. 237

TO: The Secretary of State
The Secretary of Defense
The Director of Central Intelligence

SUBJECT: Project MERCURY Manned Space Flight (MA-9)

The President is aware of the contingency planning with respect to the possibility of the landing of MERCURY 9 or future Gemini flights in the territorial waters of Communist China, North Vietnam, or Cuba, as described in the letter dated May 1, 1963, from the Deputy Under Secretary of State to the Deputy Assistant Secretary of Defense for International Security Affairs.

The President agrees that the Secretary of Defense has adequate authority to authorize the penetration of the territorial waters of the above countries for the purpose of locating, rendering assistance to, and retrieving the personnel and spacecrafts.

McGeorge Bundy
McGeorge Bundy

cc: Director, Bureau of the Budget
Administrator, National Aeronautics
and Space Administration

cc: Mrs. Lincoln
Mr. Bundy
Mr. Kaysen
Mr. Johnson
NSC Files

~~SECRET~~

(Dispatched 5/3/63)

